THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 60 Thursday, April 20, 1939 No. 1183

PUBLISHED WEEKLY

Subscription Terms : 17s. 6d. per annum.
Foreign and Colonial : 20s. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address : "Zacatecas, Rand, London."
Telephone : Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Cupola Developments

During the discussion which took place on Mr. W. W. Braidwood's Paper, which was recently printed in our columns, some criticism was levelled against cupola receivers on the grounds that they demanded a certain quantity of heat units to bring them up to an adequate temperature for receiving molten cast iron and for maintaining that temperature. In his reply, Mr. Braidwood pointed to the not-inconsiderable heat losses that were sustained through open slag notches. This factor, and the associated one of heat passing up the stack, have exercised the minds of many cupola designers probably ever since the conception of the process. An obvious solution which suggested itself to various inventors was the application of recuperators so as to provide a hot blast. Here, however, there is *inter alia* the same criticism which was expressed in Glasgow when discussing receivers, that is, the initial heat required to warm up the chequer work. In both cases, with increasing time and quantity, this constant becomes increasingly unimportant until it reaches a point at which it can be neglected and advantages begin to accrue. An American plant having a particularly large output associated with very lengthy blows has shown advantages for the hot-blast system, whilst by using excellent thermal insulation Mr. Braidwood has propounded a good case for the incorporation of receivers.

In our columns last week a new type of cupola of Italian origin was described, and the author of the Paper divided his matter into two main parts. The first section was particularly interesting, as he established by experiment the influence of a number of variables on cupola operation. The major criticism which we have to make is that the author omitted to detail the means by which he ascertained or deduced the shapes and areas of the oxidising and reducing zones. There are reasons, on theoretical grounds, to believe that the zones he details are substantially correct for the conditions cited.

The second part of the Paper deals with a type of hot-blast cupola based on the experimental work carried out by Signor Olivo. Here he has utilised the belt of the cupola as the locale for the heating up of the blast in a simple controllable manner. His figures of 50 to 300 deg. C. as indicating the range of control of blast temperature are distinctly impressive, and if his zoning sketches (Figs. 13 to 15) can be relied upon as portraying actualities, then a measure of control has been given to cupola practice which places it well within the range of a precision furnace. Whilst some correlation with routine chemical analysis, microstructure and general properties has been made, there is still need for relating the whole procedure with work that has been done on the influence of gases on metals and alloys. It is, however, germane to remark that the researches so far published do tend to confirm the intelligent anticipations of the mere observant metallurgists and practical men. When finality has been reached in cupola design, and all such factors as blast temperature, volume, pressure and internal atmosphere have become readily controllable, then more and more attention must be given to the nature of the charge, for the good reason that these refinements have been devised for the very purpose of taking care of such conditions. The controls can only be "set" with advantage if the charge is of constant unvarying quality. For instance, the latest researches indicate that excessively rusty material demands a radical departure from standard practice if the final product is to be freed from inherent and deleterious properties. We have used the word "inherent" as indicating to the practical man that, just as good pig-iron has inherently beneficial qualities which can be transferred to the casting, so too can rusty scrap act in the reverse direction. The researches covering this phase of metallurgy will no doubt be referred to at the forthcoming International Congress, and because of this it is just as well to suspend judgment on the efficacy of hot-blast, in so far as it relates to *quality*, until that time. This must not be interpreted as a condemnation of hot-blast cupolas, as there are well-experienced metallurgists who believe that material improvement in quality can be so effected, due to the higher tapping temperatures inducing sufficient superheat to ensure complete solution of the true constituents of cast iron and the elimination of insoluble ones. The development of the newer types of hot-blast cupolas—for there are more than one—will certainly be watched with interest by the iron foundry industry all over the world.

Joint Committee on Materials and Their Testing

The Joint Committee on Materials and Their Testing has issued its second annual report. The number of institutions and societies which collaborate in the work of the Joint Committee (including the Institute of British Foundrymen) is now 26, the Institution of Chemical Engineers having joined during the year. The chairman of the Joint Committee is Dr. H. J. Gough, M.B.E., F.R.S., and the Secretary Mr. G. H. Ford, M.Sc.

The Report refers to the Second General Discussion which was devoted to the subject of "Non-Destructive Testing," and was held under the auspices of the Institution of Electrical Engineers on November 25, 1938, when seven Papers were presented.

For the Third General Discussion, the Institution of Gas Engineers have accepted the invitation to act as "host" for a discussion on "The Properties and Testing of Heat-Insulating Materials" to be held in London on November 23 next. The discussion will be held in conjunction with the Autumn Research Meeting of the "host" Institution, and a sub-committee has been appointed to handle the details of the meeting. British as well as foreign authors are being invited to contribute Papers reviewing current research and opinion on (1) high-temperature insulating material; (2) low-temperature insulating material; and (3) insulation of buildings and other applications. In this way it is hoped to obtain a comprehensive survey from an international viewpoint.

In future, the Joint Committee will hold two General Discussions each year, and the place of meeting will alternate between London and a provincial centre. It is hoped that soon it will be possible to announce the subject of the meeting to be held in the Spring of 1940. A list of possible subjects for joint discussion has been drawn up.

International Association for Testing Materials.—Dr. H. J. Gough, M.B.E., F.R.S., continues to represent Great Britain on the Permanent Committee of the International Association for Testing Materials. He was represented at the meeting held at Düsseldorf in June, 1938, when arrangements were discussed for the Testing Congress to be held at Munich in June, 1940. The co-operating institutions of the Joint Committee have been requested to suggest, for transmission by Dr. Gough to the Group Presidents, the names of British authors who could eventually be invited to contribute Papers for the Munich Congress.

The American Society for Testing Materials.—Close contact has been maintained with the American Society for Testing Materials, not only through their secretary, Mr. C. L. Warwick, but also through their European representative, Mr. W. L. Cooper. Cordial thanks are due to the American Society for Testing Materials for their collaboration in providing an excellent Paper on "American Practice of Non-Destructive Testing" for the discussion held on that subject in November, 1938.

London Congress of the I.A.T.M.—The Executive Committee of the Congress of the International Association for Testing Materials, which was held in London in 1937, have proposed to convert the surplus funds of the Congress into a trust to further the aims of the Joint Committee, with special reference to any international congress held at home or abroad. It is proposed that the first trustees should be Sir Frank Smith, G.C.B., F.R.S., Sir William Larke, K.B.E., Dr. H. J. Gough, M.B.E., F.R.S., and Mr. Headlam-Morley, subsequent trustees to be appointed by the Joint Committee. The Joint Committee have accepted the trust and a trust deed is being drawn up.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Moulding Test-Bars

To the Editor of The Foundry Trade Journal.

Sir,—Your leader of April 6 on this subject suggests that the Cast Iron and Non-Ferrous Sub-Committees of the Institute of British Foundrymen should study and recommend methods of running test-bars. The Non-Ferrous Committee has already made recommendations on this subject (I.B.F. Proc., Vol. XXIX, page 351). The Cast Iron Sub-Committee, in presenting its report for discussion at the Branches during the past session, has invited suggestions for methods of running test-bars, and these suggestions, together with the Sub-Committee's considered reply, will be published in the near future. Whilst I cannot anticipate the Sub-Committee's reply, I can state that certain recommendations will be made.

The question as to whether or not such recommendations should be appended to specifications is a larger question which has not been specifically considered by the Sub-Committee, but my personal feeling is that cast iron covers such a wide range of types of material that any hard and fast specification would not be advisable.—Yours, etc.,

Philip A. Russell
(Convener, Cast Iron Sub-Committee, I.B.F. Technical Committee).

Bath Lane, Leicester.
April 7, 1939.

Manganese in Steel

In a Paper in the "Journal of the Society of Chemical Industry," entitled "The Determination of Manganese in Steel with Special Reference to Highly-Alloyed Corrosion- and Heat-Resisting Steels," B. Bagshawe points out that for the determination of manganese in chromium and other alloy steels, the method which has been used for many years is based on conversion into permanganic acid with sodium bismuthate following a zinc-oxide separation of the iron-chromium group from neutralised sulphate solutions. For some time it has been apparent that this method falls short of requirements in that it is not sufficiently flexible and convenient for use on the more complicated and varied alloy combinations found in modern steels. Experiments with a modified form of zinc-oxide separation from perchloric-acid solutions have shown that under properly controlled conditions a perfect separation of iron and chromium from manganese can be obtained. The use of perchloric acid opens up the possibility of rapid dissolution of almost any type of steel by means of mixed hydrochloric and nitric acids followed by perchloric acid "fuming" which ensures complete decomposition of complex acid-resisting carbides. The great advantage of this treatment is that almost any type of steel can be handled in a minimum of time by a standardised solution treatment which does not require modification to meet individual cases. A persulphate finish is recommended, operating in sulpho-phosphoric solution which ensures permanganate stability and thus permits complete destruction of excess of persulphate and subsequent titration with ferrous sulphate and permanganate. There is no danger of interference from chromium, since under specified conditions the removal of this element at the zinc oxide stage is almost quantitative. The method is applicable to cobalt steels.

International Foundry Congress Funds

FIRST LIST OF SUBSCRIBERS

For the International Foundry Congress, to be held in London from June 12 to 17, it has been estimated that a sum of £900 will be required adequately to entertain the large number of overseas foundrymen and their ladies who are expected to attend in addition to the members of the Institute of British Foundrymen. As a result of a preliminary appeal which has been made to the industry, the Institute of British Foundrymen gratefully acknowledges the receipt of £418 9s., which includes the following subscriptions:—

	£	s.	d.
Members of the Foundry Trades' Equipment and Supplies Association, Limited (Guaranteed)	100	0	0
National Ironfounding Employers' Federation	50	0	0
Austin Motor Company, Limited, Birmingham	50	0	0
Vickers-Armstrongs, Limited, London	50	0	0
Mr. E. J. Fox, Stanton Ironworks Company, Limited, Nottingham	25	0	0
Lake & Elliot, Limited, Braintree	25	0	0
British Ironfounders' Association, Glasgow	25	0	0
S. Russell & Sons, Limited, Leicester	10	10	0
Kryn & Lahy, Limited, Letchworth	10	10	0
W. Jacks & Company, Limited, London	10	10	0
Herbert Morris, Limited, Loughborough	10	10	0
James Durrans & Sons, Limited, Penistone	10	10	0
Manganese Bronze & Brass Company, Limited, London ...	10	10	0
Carborundum Company, Limited, Manchester	10	10	0
Incandescent Heat Company, Limited, Smethwick	5	5	0
British Pigirons, Limited, London	5	5	0
Hinckley's, Limited, Sheffield ...	2	2	0
Foundry & Engineering Company, Limited, West Bromwich ...	2	2	0
Corn Products Company, Limited, London	2	2	0
Mr. V. C. Faulkner, London ...	2	2	0
General Metallurgical & Chemical, Limited, London	1	1	0

It is hoped that the 1939 International Foundry Congress will be an outstanding one in order that the generosity shown to British foundrymen when attending similar congresses overseas, and on many other occasions, may be reciprocated, and those who are interested are invited to send their subscriptions to the Congress Funds to Mr. T. Makemson, Secretary, the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3. All contributions will be acknowledged, and a further list of subscribers will be published in these columns.

More Steel Shelters

Orders for a further 1,000,000 portable steel shelters are being placed by the Government. These will follow the first instalment of 400,000 shelters, delivery of which began on February 25. Orders have already been placed for 100,000 sets of material for strengthening basements. This is a preliminary order. The number of steel shelters distributed to householders at Government expense now approaches 300,000. During the past fortnight material sufficient for 80,100 shelters have been collected by the railway companies from the manufacturers and delivered in 26 towns, which take 49,500 shelters, and in 19 of the Metropolitan boroughs, which receive a total of 30,600.

Wear-Resisting Alloys*

USES FOR NICKEL-CHROME CAST IRONS

By J. E. HURST

These remarks are confined to the study of nickel-chromium alloys having chemical compositions lying between the following approximate limits:—Total carbon, 2.0 to 4.0 per cent.; silicon, 0.25 to 1.5; nickel, 3.0 to 7.0; chromium, 0 to 2.5 per cent. Alloys within that range may be correctly described as high-duty hard wear-resisting cast irons and the limits of composition cover those alloys which are manufactured and sold under trade names as Ni-Hard, Attritard, BF 954 and others. In addition to the constituents mentioned they contain manganese, sulphur and phosphorus, all of which have an important influence on the properties and service behaviour of the alloys and are normally present in amounts within the limits of those usually present in alloy cast irons of this type. These alloys have a hard white fracture in all but exceptionally heavy-sectioned castings, where the fracture may be mottled to grey according to the mass of the casting. The Brinell hardness of the alloys in the white condition lies between the limits of 500 to 700, and they possess a tensile strength of about 22 tons per sq. in.

Structure

The essential structure characteristic of these alloys in their hardest condition is that the matrix of the structure is martensitic as distinct from pearlitic in ordinary white cast irons. Alloys of this type find a use in castings which are required to withstand heavy-duty wear-resisting conditions. Rolls, crushing and pulverising-machinery parts used in crushing and grinding

Table I.—*Structure and Hardness.*

Analyses (per cent.).	Martensitic.	Austenitic.
Total carbon	2.56	2.70
Silicon	0.49	0.39
Manganese	0.30	0.35
Sulphur	0.064	0.064
Phosphorus	0.09	0.09
Nickel	4.16	6.58
Chromium	1.43	1.78
Brinell hardness ..	477	340
Modulus of rupture* ..	35.4*	45.0*

* Tons per sq. in.

operations in the cement, fuel, paper, cereal and rubber-making industries, pump bodies, impellers, pipes, elbows and lines for use in connection with minerals, sand and ash, also sand-blast nozzles, blades and liner plates in sand-handling plant, are among the types of uses where materials of this type have given excellent service results.

In considering nickel-chromium alloys of this type it is convenient to regard them as essentially alloys containing approximately 4.5 per cent. of nickel and 1.5 per cent. of chromium. It is possible to draw upon the investigations of Taniguchi to illustrate that this combination of nickel and chromium in conjunction with carbon of approximately 3.0 per cent., silicon 0.40 per cent., manganese 0.47 per cent., sulphur 0.033 per cent. and phosphorus 0.50 per cent., gives the maximum hardness. Under the conditions of these experiments, the increase in nickel and chromium in combination changed the pearlitic character of the matrix to sorbite, and from a nickel content of 3.06 per cent. and chromium 1.08 per cent. a martensitic structure appeared until in the hardest specimen, containing nickel 3.88 per cent. and chromium 1.27 per cent., there showed a decidedly martensitic structure containing some austenite. The further addition of these elements decreased the martensite gradually with the increase of austenite until in the specimen containing nickel 6.14 per cent. and chromium 2.28 per cent., the martensite almost completely vanished and the structure consisted mainly of the austenite matrix and the cementite carbide. The hardness values increase with the change from pearlite to martensite and decrease again as the martensite changes to austenite. An example illustrating this is given in Table I.

The test results on these two bars were obtained in the "as-cast" condition using the

Table II.—*Influence of Manganese.*

	1.	2.	3.	4.
Total carbon ..	2.73	2.67	2.89	2.62
Silicon	0.49	0.40	0.40	0.48
Manganese ..	0.38	0.69	0.90	1.10
Sulphur	0.09	0.09	0.09	0.09
Phosphorus ..	0.09	0.10	0.09	0.09
Nickel	4.71	4.64	4.56	4.56
Chromium ..	1.49	1.54	1.49	1.46
Firth D.H., transverse	496	456	436	380
Ditto, tensile ..	465	399	395	393
Tensile strength*	20.4	19.3	14.12	15.4

* Tons per sq. in.

standard 1.2 in. dia. bars, and the effect of increased nickel content and chromium in bringing about a lower hardness value is clearly shown. This is the result of the increased amount of austenite present, which is confirmed also by the magnetic properties. The influence of manganese is important in this same connection, and the test results given in Table II illustrate this.

Effect of Manganese

In this series of tests, the manganese content was increased from 0.38 per cent. to 1.10 per cent. The hardness results on the 1.2-in. dia. bar in the as-cast condition show a falling off from 496 to 380, a total of 112 points, and this bar on test was found to be only feebly magnetic, indicating an increase in the austenitic condition. The tensile-test bars cast to a smaller diameter likewise show a falling off but behave differently, and this will be referred to later.

There are two ways in which this drop in hardness due to increase in manganese may be considered. It is possible to consider the total drop of 112 points as being due to the influence

Table III.—*Effect of Quenching on Hardness.*

	No. 1.			No. 2.		No. 3.	
As cast	488	464	488	488		488	
Oil quenched—							
750 deg. C. ..	772	824	824	—		—	
850 deg. C. ..	661	642	662	—		—	
950 deg. C. ..	488	464	442	—		—	
1,050 deg. C. ..	328	328	322	312	320	305	320
Oil quenched 1,050 deg. C.—							
Temp. 500 deg. C.		—		488	518	—	
,, 600 deg. C.		—		671	671	—	
,, 700 deg. C.		—		—		746	719
Water quenched 1,050 deg. C. ..		—		352	320	305	320

of manganese in promoting the austenitic structure. In this case the drop would be due to an increment of 0.72 per cent. manganese or 15.5 points for each 0.10 per cent. manganese. The alternative is to take into consideration the effect of manganese on the sulphur content. In this case utilising the results of Norbury for the neutralisation of the sulphur a percentage of manganese of 0.30 per cent. plus about twice the sulphur content, in this case 0.18 per cent., making a total of 0.48 per cent. manganese, is required to neutralise the sulphur present. The results in Table II do not enable one to take this effect exactly into one's calculations, but the author is sure this effect should not be overlooked, and for this reason the drop in hardness due to the effect of manganese in promoting austenite may be something less than the former figure.

Reference to Table I shows that the total reduction in hardness due to manganese is about the same as that due to the increase in nickel content from 4.48 per cent. to 6.58 per cent., that is 2.10 per cent. Under the conditions of these experiments, therefore, manganese has about three times the influence of nickel in bringing about reduction of hardness. Its influence in promoting austenite, whilst more powerful, may be less than this relationship. In any case too much importance must not be attached to these numerical relations as they only hold under the particular conditions of this experiment. Their value is to show, as would be expected, that the influence of manganese is of great importance in this type of nickel-chromium alloy due to its tendency to promote the formation of austenite and consequently bring about a lowering of the hardness value.

The strength values are shown to have fallen substantially with the increase in manganese. The percentage drop in strength is greater in the tensile test-pieces than in the transverse bars, being about 20 per cent. in the former and 10 per cent. in the latter. In the previous experiment in which the austenitic condition was brought about by increase in nickel content, a higher breaking strength was obtained in the more austenitic bar. In this respect, the influence of manganese appears to be different from that of nickel.

The other important constituents are, of course, carbon and silicon. Increase in carbon tends to increase the hardness values and in

Table IV.—*Composition of Specimens referred to in Table III.*

	No. 1.	No. 2.	No. 3.
Total carbon ..	2.56	2.67	2.78
Silicon	0.49	0.52	0.49
Manganese	0.30	0.39	0.36
Sulphur	0.064	0.07	0.068
Phosphorus ..	0.09	0.10	0.10
Nickel	4.16	4.63	4.52
Chromium	1.43	1.50	1.38
Molybdenum ..	—	—	0.13

general increase in silicon tends to lower the hardness values, particularly where sufficient is present to have an effect on the amount of free carbide present. Phosphorus is of importance from the point of view of strength considerations, and where maximum strength is required it is advisable to keep the phosphorus down to low limits.

These alloys are susceptible to heat-treatment and some experiments have been made to ascertain the effect of quench hardening and tempering. In all cases the tests have been carried out on 1.2-in. dia. bars in the as-cast condition. The effect of quench hardening treatments on the Firth diamond hardness values are summarised in Table III.

The chemical composition of the three specimens in Table III is given in Table IV.

Quenching at temperatures of 750 deg. C., and 850 deg. C., is accompanied by an increase in hardness. From the higher temperatures of 950 and 1,050 deg. C. a drop of hardness values similar to those obtained due to the effect of extra nickel or manganese in promoting the austenitic structure is experienced. The effect of tempering after quenching from 1,050 deg. C. is interesting. It will be observed that tempering at successively higher temperatures is accompanied by the recovery of hardness value and the restoration of the martensitic condition. By

(*Continued on page* 324.)

* From a Paper read to the Midland Metallurgical Societies on March 30.

Fifty Years' Progress in Steel Founding

DISCUSSION ON LARGE SHIPS' CASTINGS

The history of the steel-foundry trade during the last 50 years was discussed in a lecture given recently to the Middlesbrough Branch of the Institute of British Foundrymen by Mr. F. Swift, foundry manager of the Darlington Forge, Limited.

Mr. Swift described the various innovations and developments, and said that the state of perfection attainable to-day was due to the early pioneers. The Darlington Forge, he said, was built in 1888. During the first year that concern made three sternframes, and in the second year fifteen. It gradually built up a world-wide reputation, and some of the largest and most intricate structural castings had been made for ships such as the "Carmania," "Oceanic," "Titanic," "Olympic," "Mauretania," "Queen Mary" and (latterly) the new "Mauretania."

Mr. Swift's lecture was illustrated by a series of lantern slides depicting the developments of the last 50 years, and by an exhibition of scale models of steel structural castings made by Darlington Forge for famous ships. Two of these are illustrated in Figs. 1 and 2.

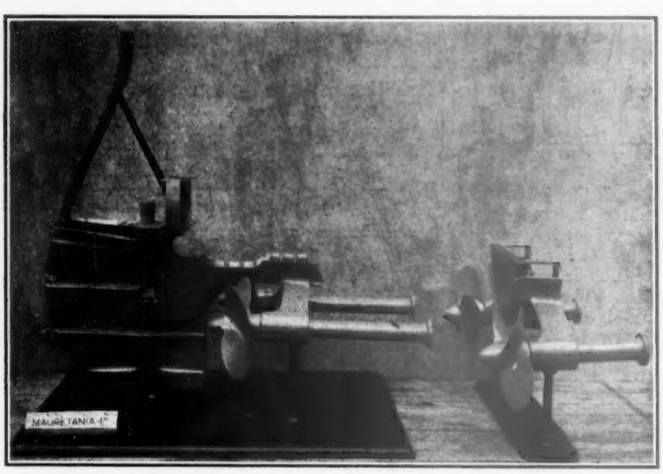


Fig. 1.—Model of Castings for the Old "Mauretania."

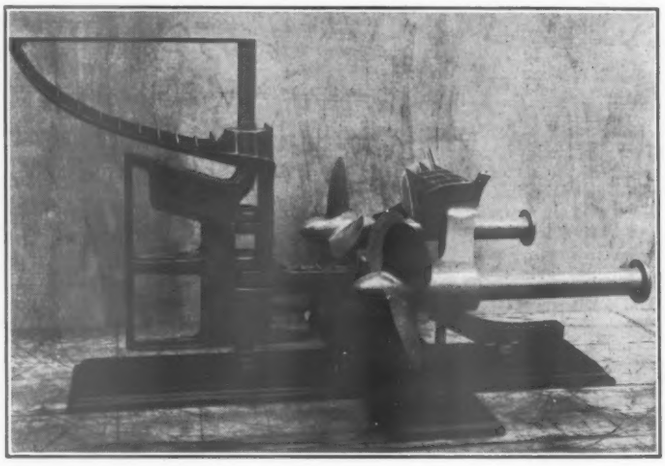


Fig. 2.—Model of Castings for New "Mauretania."

DISCUSSION

Mr. J. E. Mercer, proposing a vote of thanks, said there were several things which had puzzled him. For instance, some of the castings referred to were nearly 40 ft. long, with sections from ¾ in. to ⅞ in. thick. A casting of this type obviously set very soon after it had been poured. What provisions were made for releasing the strains and taking up the large contractions, and what were the methods of running?

Mr. Swift demonstrated on a model of a ribbed channel-section casting about 37 ft. long. The contraction, he said, would be from 4 in. to 4¼ in. The principle was for the moulder to keep the bars at least 3 in. away from each rib, and to put plenty of ashes between the black sand and the bars. The casting was run both ends on the thin sections from two ladles.

Mr. Mercer remarked that, in channel or E-section castings, such as were used for the "Queen Mary," he would expect to find a series of waves in the flanges, where the ribs were pulling in.

Mr. Swift said he had never experienced distortion of this kind. Occasionally he had found the ribs staggered, but he thought this was due to the moulding. Plenty of ashes were always used to prevent distortion.

Mr. McCulloch asked how long it took to run the big ship castings referred to.

Mr. Swift said he had two ladles, one of 60 tons and the other of 40 tons capacity, pouring at 4 to 4¼ tons per min. He found that in the casting he had just mentioned it was necessary to pour 46 to 50 tons of steel; otherwise the webs ran short.

Mr. Cooper said he had been interested to discover that the contraction on big castings was not always a constant, and, in fact, varied within wide limits. He asked whether this was due to the temperature or the composition of the metal.

Mr. Swift replied that the variation in contraction was due to the temperature. The temperature of pouring could not be controlled too closely. The temperature of the mould might affect it slightly.

Mr. Pugh said that high-carbon steels were poured at a lower temperature; therefore, lower contractions might be expected, and composition would have some bearing on contraction. The tendency nowadays was for the ship constructional castings to be larger and more intricate. In former days, ships were built around the castings, but to-day the castings were ordered after the construction of the ship had been started, and therefore had to be much more accurate.

Mr. Cooper asked whether alloys had any effect on contraction.

Mr. Swift replied that all the castings he had been describing were of straight carbon steel. Aluminium was the only addition, introduced into the ladle as a deoxidiser, and to improve fluidity. He had not observed that alloys had much bearing on contraction. The temperature of the metal was the deciding factor.

Mr. Pugh asked what differences had taken place during the last 50 years in the sands.

Mr. Swift said he had heard that in 1888 it took from three to fourteen days to uncover a casting. It was quite common for fettlers to use a hand hammer and chisel. He thought that, at first, the same sands had been used as for iron. He had once seen a street being excavated in Sheffield and had noticed several old pots being dug up where there had once been a foundry making crucible-steel castings. Evidently they had not realised in those days the value of old pots. In 1884, the majority of steel moulding compositions were developed. When the open-hearth process came into use the improvement was rapid.

Mr. Mercer said that, 42 years ago, at Vickers, they were producing steel castings with a skin equal to any to-day. The facing composition was a mixture of china clay, blacklead and coregum mix. He mentioned propeller blades as an example.

Mr. Swift agreed, and mentioned that his father had told him that a propeller boss, weighing 3 tons, and with runners 6 ft. long, had once taken a week to "find."

Mr. Mercer wound up the discussion, and said it was a pleasure to note the keen interest which had been taken in this lecture by the staff of the Darlington Forge, and by Mr. Pugh in particular.

Wear-Resisting Alloys

(*Concluded from page* 323.)

tempering at 700 deg. C., after quenching from 1,050 deg. C., in oil, a diamond hardness value of 750 approximately was obtained, a figure very similar to that obtained by direct quenching from temperatures in this neighbourhood. This is a method by which extremely high hardness values can be obtained in this material.

The object in presenting these few experiments is to show that in this range of nickel-chromium alloys lies a material which possesses wear-resisting properties of a very high order and of considerable commercial importance. It is possible to bring about variations in the properties of the alloys by changes in the chemical composition. Increases in nickel and chromium and manganese tend to reduce the hardness and bring about the austenitic condition. For some conditions of wear resisting this condition might be advantageous. Reduction in hardness can be also brought about by reduction in carbon content and *vice-versa*, and here again there are wear conditions which might be more advantageously met by modifications in composition of this type. The alloys are susceptible to heat-treatment by quenching and by quenching and tempering. Quenching alone from a sufficiently high temperature is another method of obtaining the austenitic condition, and this treatment corresponds to the oil-toughening treatment used in connection with certain steels. Quenching to the austenitic condition followed by tempering can be used to obtain a very high degree of hardness, and in a similar manner quenching at low temperatures of the order of 750 deg. C. brings about increase in hardness.

Enough has been said to show that a wide range of variations in properties can be obtained in these alloys, and, the author thinks, also to show that little enough is yet known about them in view of their real commercial importance.

The Foundries of J. & E. Hall, Limited, Dartford

Historical

Four years ago the firm of J. & E. Hall, Limited, of Dartford, celebrated its sesqui-centenary, and at that time Mr. Everard Hesketh, who was a director of the concern for more than fifty years, embodied its history in an extremely interesting book.* The original John Hall, who was born in 1704, had two sons, John and Edward. Both these engineers became their father's partners, and the former was associated with the business until his death in 1850 and the latter until 1875. As Mr. Hesketh joined the firm only three years after the death of Edward, it is obvious that he was in a splendid position to derive intimate and reliable information as to these great engineering pioneers.

The successful continuation of a firm seldom rests on the energies of but one family, but rather the ability of the owners of the concern to surround themselves with people of outstanding capacity. This factor crops up repeatedly in the history of the firm. For instance, on the advice of Smeaton, Bryan Donkin was apprenticed to John Hall in 1792 and later married his sister. He devoted most of his life to the developments of paper-making machinery. A still more prominent engineer, Richard Trevithick, "probably the greatest mechanical genius of the nineteenth century," was engaged at these works during the last years of his life. He died in reduced circumstances in 1833 and was buried in the graveyard of a local church.

The character of the firm has obviously changed from time to time. For the first hundred years of its existence, it carried on the business of general engineers and founders, orienting the nature of the production according to the requirements of the moment. In 1850 a large consignment of guns was made and sent to a Mexican fort. They were later captured by the Americans and some of them are now exhibited in the grounds of West Point Military Academy. The immediate pre-war period saw the firm almost exclusively engaged on refrigerating machinery, but the exigencies of the time caused the firm to undertake much munition work, including petrol-driven lorries, paravanes, bomb-release gear and field-gun equipment. Nowadays, the main specialities of the firm are land and marine refrigeration, lifts and escalators.

The extent of the activities can be judged by the fact that they employ more than 2,500 people. Naturally, a large engineering establishment of this character requires foundry services of a high order, and the search for quality which has animated the firm's activities since its inception is to-day the most prominent feature. There are three foundries, heavy and light iron and non-ferrous, but they are not contiguous, and no serious drawback is noticed, as the iron foundries feed two heavy and light machine shops.

The Heavy Iron Foundry

The heavy iron foundry, shown in Fig. 1, is housed in a building 318 ft. long by 70 ft. wide and 23 ft. high to the crane track. Internal handling is effected by three overhead electric travelling cranes of 30, 15 and 10 tons lifting capacity, supplemented by jib cranes—one of which, situated in a corner, is retained as being of historical interest, having been erected in 1878.

External Transport

Raw materials for the melting plant arrive by lorry and unload into the stock-yard bins, from which they are weighed out into self-tipping buckets. These are picked up by a hook suspended from a monorail and hoisted and racked into the cupola charging hole. Here, by means of the actuation of tipping mechanism the contents are dropped into one of the furnaces. For weight control a spring balance is interposed between hook and bucket.

Melting Plant

Metal is provided by two Evans cupolas, one of 36 in. diameter yielding 4½ tons of metal per hr. and the second of 42 in., which has a capacity of 6½ tons per hr. The furnaces are brick-lined, iron bricks being incorporated below the charging door to minimise repairs in this region. They are furnished with two rows of 6 in. by 4 in. splayed tuyeres, there being three in each. Pressure is maintained at 20 to 26 in. water-gauge, and blowing is effected by a Roots blower, with a Keith-Blackman fan as a standby. For patching, about 56 lbs. of plastic refractory is used per ton of throughput. Liquid metal is handled by Collin-type ladles, the largest of which has a capacity of 15 tons. This shop has an output of the order of 40 tons of finished castings per week.

The Perlit Process

Special problems have had to be overcome in this shop because the Perlit or hot-mould process is extensively practised. In principle this requires a correlation between mould temperature, composition of metal and average cross-sectional area of section, so that the ultimate microstructure of the metal carries a wholly pearlitic matrix associated with a finer graphite structure. In practice, standardisation appears to start with a fixed temperature of 400 deg. C., for the moulds and compositional adjustments are made to suit. It is apparent that the system requires a departure to be made from what is now considered as normal core practice, for ordinary oil-sand mixtures break down. Facing sands are prepared in an August-Simpson bucket loading self-emptying mixer carrying a 5-ft. pan, whilst loam is mixed in an ordinary pug mill. Moulding is in general carried out from either loose patterns or strickles. Extensive use is made of pneumatic rammers.

Fig. 1.—The Heavy Iron Foundry seen from the North End.

Fig. 2.—One of the Drying Stoves in the Heavy Foundry.

Mould Drying and Heating

The shop carries an important installation of mould stoves, two of which were built by Priest's, of Middlesbrough. Their internal dimensions are 25 ft. deep by 14 ft. wide by 9 ft. 8 in. high, and they are coke-fired, using forced draught, the draught being supplied by a Keith-Blackman fan driven by a 2.5-h.p. electric motor. The handling in and out of the bogies is effected by crane through the use of an anchored snatch block. This plant is illustrated in Fig. 2, from which it will be seen that it carries a roller shutter as a door. In addition there are two other stoves, one of which uses natural draught.

Fettling

Whilst the Perlit system gives a fine outer skin to the castings, the removal of cores is a shade more difficult than is encountered in shops not utilising this process. Thus, a large-scale Tilghman shot-blast plant has been installed. The chamber is 9 ft. wide by 12 ft. long, and along its floor run light-gauge rails. On this track run two bogie wagons, and whilst one is being unloaded and reloaded, the other is within the chamber, and the cleaned castings leave by the end opposite to which they entered. The

* "J. & E. Hall, Limited," by Everard Hesketh, M.Inst.C.E. (Glasgow University Press).

bogies are so constructed that their tops form a turntable, for ease of operation within the chamber. For the removal of fins, extensive use is made of A.W. pneumatic chippers.

Light Iron Foundry

The light iron foundry, carrying (as do far too many shops of this character) a low roof, is difficult to photograph. Raw materials for melting are handled in much the same way as for the heavy foundry. The melting plant consists of two cupolas, one of 36 in. diameter being of the Poumay type, carrying the spiral arrangement of the tuyeres and melting about four to five tons per hour. The second is 30 in. inside diameter. This is of the low tuyere type and brings down 3 to 3½ tons an hour of very hot metal.

The shop, which is 14 ft. high to the crane track, is divided into five bays. The handling of metal and moulds is effected by five floor-operated overhead Vaughan travelling cranes, three of 3 tons, one of 4 tons and one of 2 tons lifting capacity, augmented by a complete transveyor system. Sand preparation is effected by a 5-ft. pan August-Simpson intensive mixer and a pug mill. Core-sand mixing is at the moment being changed and new plant is on order. Though the Perlit system is also extensively practised in this shop, quite a number of moulds permit of the use of oil-sand cores. This factor is interlinked with production methods by utilising the waste gases from the two mould-drying ovens, which were built by Priest, and measure 17 ft. deep by 19 ft. 6 in. in one case and 10 ft. wide in the other, to heat up four rack-carrying type core stoves measuring 10 ft. by 5 ft. by 7 ft. Baking in the core stove is effected at temperatures ranging from 200 to 225 deg. C. maximum.

Moulding Plant

Sand and other materials are moved about the shop by means of Greenwood & Batley petrol-driven trucks. As the majority of the moulds have to be heated up to a temperature of 400 deg. C., they are placed on parallel light rails fitted with loose sand, prior to and after stoving. The main, though by no means entire, production of this foundry is the manufacture of components for refrigerators destined for use in hotels, stores and shops. A Zimmermann R.P.W.4 machine is engaged on the production of small flywheels, lift wheels and ammonia valve bodies, whilst a pair of U.G.0 machines by the same designer makes small components for the "Hallmark" compressor. Crankshafts are made on a U.G.2 machine. For these castings a 25 per cent. steel mix iron is used, and the composition is standardised at T.C, 2.9 to 3.0; Si, 1.4; Mn, 0.8; S, 0.09; P, 0.15 to 0.20; Ni, 2.0 and Cr, 0.8 per cent.

A Mumford pull-down squeeze machine carries out snap-flask work for such components as refrigerator pistons, valve units and oil-separator bodies, whilst an Osborn turnover machine carrying a 6-ft. table is used for making twin monobloc cylinders made as one unit, flywheels, and the marine type of "Hallmark" refrigerator base-plates.

Most of the side bay opposite to the drying stoves is devoted to fettling. The plant utilised includes a Tilghman shot-blast chamber measuring 6 ft. by 6 ft. by 8 ft. 3 in.; a shot-blast tumbling barrel by the same makers, and a few double-ended grinders.

The Brass Foundry

This modest department is particularly well housed in a shop which is 80 ft. long by 35 ft. 8 in. wide and 16 ft. 6 in. to the eaves. Melting is effected in two 400-lb. (brass capacity) coke-fired Morgan tilting crucible furnaces and a 250-lb. furnace of the same make. In addition, there is a Polford furnace of 100 lbs. capacity which is mainly used for melting special irons and general experimental work. For core drying, there is a natural-draught coke-fired oven, whilst mechanical moulding is effected on a Zimmermann U.G.0 and a Mumford squeeze pull-down machine. As aids to fettling, there are a band saw and a double-ended grinder. A general view of the shop is shown in Fig. 3.

Patternshops

Because of the extensive nature of the woodworking requirements of the firm on account of the manufacture of escalators, lifts and cabinets of various kinds, there is no clear line of demarcation between the patternmaking and woodworking. However, in general, patternmaking is carried out on the first floor of a particularly well-equipped general woodworking department, but the largest patterns are assembled on the ground floor. Access to the first floor is gained by lift and leading from the first floor is a veritable maze of pattern stores; this obviously well-organised department houses not only the patterns currently used, but those for spare parts made necessary by more than 150 years of manufacturing existence. The patternshops have every modern piece of equipment possible, ranging from electrically-heated glue pots to universal woodworkers. Throughout there is a sprinkler system, whilst both general and local lighting is excellent. Practically all the machines are equipped with dust extractors.

Metallurgical Control

Situated centrally in the works is a well-equipped series of metallurgical laboratories. The mechanical testing laboratory has an Amsler Universal, an Izod impact, and an Avery Brinell testing machine. Here, too, a mechanical polisher for micro-sections has been installed, and the structures of metals are examined by a Vickers microscope. This department is supplemented by a chemical laboratory which is essentially modern in design and equipment.

Welfare

The firm is justly proud of its social activities, and especially of the veterans' club founded in 1927, membership of which is confined to those having 25 years' service with the firm. This club is housed in the works' canteen, which is licensed and looks very little like a canteen and very much like a club.

The welfare department also includes the usual safety-first activities and embraces all the customary sports, such as cricket, football, tennis, bowls and darts.

Fig. 3.—The Brass Foundry.

Fig. 4.—Base Plate for a CO_2 Compressor (Horizontal Type), made in the Firm's Foundry.

The writer wishes very sincerely to thank the directors and staff of the company—especially Mr. Pincott, of the foundry—for the help given in the preparation of this article.

Iron and Steel Production

The British Iron and Steel Federation reports that there were 95 furnaces in blast in the United Kingdom at the end of March, compared with 88 furnaces at the end of February, seven furnaces having resumed operations during the month. The production of pig-iron in March, at 603,600 tons, included 96,700 tons of hematite, 380,100 tons of basic, 100,900 tons of foundry and 11,300 tons of forge pig-iron. The March figure which compares with 516,000 tons in February and the recent low level of 429,800 tons in September last, is the highest since May last, when 633,900 tons of pig-iron were made.

Steel production at 1,170,900 tons in March compares with 971,100 tons in February and the lowest figure in the last twelve months of 655,700 tons in December. The March total parallels the peak levels of the autumn of 1937, and is only fractionally below the highest monthly production ever recorded. The increase in production has been common to all the steelmaking districts. Owing to the increase in steelmaking capacity since 1937 there is plant available for further increase in the output rate should this be required.

Nickel in the Non-Ferrous Foundry

DISCUSSION OF MR. FRANK HUDSON'S PAPER

The Paper by Mr. Frank Hudson on "Nickel in the Non-Ferrous Foundry" has been printed in our March 30 and April 6 issues. When it was presented to the annual joint meeting of the London Branches of the Institute of British Foundrymen and the Institute of Metals, over which Mr. Barrington Hooper presided, it gave rise to an interesting discussion, the main points of which have been abstracted below.

Correlation of Test-piece and Casting

Mr. W. A. C. Newman (Chairman of the London Section of the Institute of Metals), having expressed thanks to Mr. Hudson for his extremely interesting and useful Paper, said he was not sure that finality had yet been reached with regard to the relationship between test-pieces and castings, whether the test-pieces should be cast separately or whether they should be attached to the castings they represented. The fact remained, however, that test-pieces cast separately under special conditions must give test results under the very best conditions, and therefore represented a standard by which other results could be gauged.

With regard to pouring temperature, he could not help being impressed by the thought that it was possible for a distinct difference in temperature to exist between the metal in the riser and the metal in the gate, resulting, of course, in differences in properties, and possibly porosity in one part whilst retaining soundness in another. The quantity of metal being cast had a distinct bearing on that point, but sometimes founders lost sight of it; on occasions one tried to arrange a big melt to make a large number of castings, whereas it might be more profitable ultimately to have a smaller melt and to make a smaller number of castings.

A point of considerable interest was that, whereas the modern high-speed crucible gave quicker melting, there was also quicker cooling during pouring; and he mentioned two instances in which steps had been taken to modify, if not actually to inhibit, the cooling during the casting operation. In the well-known chlorine refining process for gold, one crucible was heated within another; the outside crucible served the double purpose of conserving any gold which was spilled in the event of the inside crucible becoming cracked, and, equally important, of retaining the heat within the inner crucible whilst that particular portion of refined gold was being melted. The second instance concerned the making of certain types of chilled strip castings where the crucible was held in a cradle while the moulds were placed in front of the crucible. It had been found expedient and extremely useful to surround the crucible, when in the cradle, by a sheet-iron shield lined with refractory material, which afforded protection from drafts to a considerable extent and at the same time helped to retain the heat in the crucible during the actual pouring period, which for strip castings was extremely long as compared with that of the ordinary foundry castings in sand moulds.

Heat-Treatment of Non-Ferrous Castings

Mr. A. J. Murphy commented that during the past few years new ideas had been applied to melting conditions, and it seemed that they might completely revolutionise foundry practice in that respect. It had been of particular interest to hear Mr. Hudson's uncompromising condemnation of the use of charcoal as a cover for melting copper alloys, because ten years ago there would have been no denial that it was good practice to melt under charcoal.

The problem of heat-treatment was of increasing interest, and the economic question very soon arose as to whether or not it was justifiable to achieve certain properties by means of heat-treatment. It was pleasing to note that, in quoting the American results, Mr. Hudson had given the periods of solution treatment, because very often they were omitted when reference was made to the heat-treatment of sand castings by a two-stage process. It was surprising that the solution treatment quoted for the copper-nickel-tin and copper-nickel-zinc alloys was so short; he asked whether the samples used were sand or chill castings, and, if they were sand castings, what was their section.

With regard to the system of oxidation associated with the name of Lepp—some alternatives to which had been mentioned in the Paper—he asked what Mr. Hudson conceived to be the function of the fluid slag that was used; he pointed out that oxidation could be produced, of course, by powdered copper oxide, without the use of fluid slag.

Forms of Porosity

Mr. J. Cartland drew attention to two distinct kinds of porosity, one kind being in the form of spherical-shaped blowholes which might be either of great size or very minute and widely distributed, and the other being in the form of minute cavities which appeared to follow the crystal boundaries. The two kinds of porosity were quite distinct in appearance. He believed the first kind was due to absorbed gas coming out of solution when the metal solidified, and he would be glad of the author's opinion as to the cause of the second kind of porosity.

Mr. J. B. Watson asked if Mr. Hudson could give some information concerning the trend of modern melting practice in connection with the base metals, such as the brasses, as distinct from the better type of alloys.

A Lesson from Iron-Foundry Practice

Mr. A. Logan said one must be impressed by the lack of progress which was apparent in the non-ferrous foundry during the last twenty years as compared with the ferrous foundry. In cast iron, for instance, there had been an amazing development of new alloys and new discoveries, which had been put to use and were serving very useful purposes in engineering; and he was rather concerned to know why such progress had not been made in the non-ferrous world. There were several obvious factors which might account for it. There were probably several hundreds of non-ferrous foundries in this country, many of them very small, unfortunately. He imagined that the more progressive were those associated with large engineering concerns, and which had adequate scientific and metallurgical control. To a considerable extent the non-ferrous foundries had been left to their own devices; and he imagined that in many of them, if asked to produce an alloy such as the 88/5/5/2 (nickel-bronze), without previous experience or metallurgical aid, failure would be inevitable. That was due, he suggested, to lack of scientific control, and he urged that progress in non-ferrous founding would be made only when a state of affairs was reached somewhat similar to that achieved in the iron foundry. One felt a little more optimistic, however, after hearing Mr. Hudson's *résumé* of modern non-ferrous foundry practice, for it seemed that we were entering upon a new era in which new alloys were coming along; and when a demand for them arose in engineering, the non-ferrous foundries would have to fall into line and put themselves into a position to be able to produce them.

There was no doubt that current ideas regarding fluxing and de-gasification were undergoing very rapid change, and ideas which were held ten years ago were having to give place to new ones. When there had been time to investigate further, it would probably be found that the properties of even the ordinary brasses and bronzes could be considerably improved and modified in the future.

Degasification

Mr. J. E. Newson, who referred to the de-gasification process as being truly revolutionary, said that in the first place one set out to produce an oxidised state in the alloy, and then one had to reverse the conditions and completely eliminate the oxides. Mr. Hudson had stated that it was necessary to have an excess of oxide present to produce complete de-gasification. Yet, if all the oxides were not completely removed, there was the danger that these oxides might produce unsoundness. Sometimes, in products made largely from old scrap or borings, minute particles of oxide lodged between the dendrites, and prevented the last molten part of the alloy from completely filling the inter-dendritic spaces, and cavities resulted, giving a weak material. With reference to deoxidising by means of phosphor-copper, he had always been under the impression that one could not deoxidise fully by that means, and he asked what further treatment was necessary to ensure that the removal of oxygen and added oxides was, in fact, complete.

Author's Reply

Mr. Hudson, replying to Mr. Murphy's reference to the age-hardening of the nickel-bronze alloy, said the tests were conducted on the standard tensile test-bars of roughly 1-in. diameter. The results given were obtained in America, but metallurgists in this country had been doing active research work on the alloy. Considerable attention had been devoted to the heat-treatment of gear blanks about 1½ in. thick, and it was found that, provided they were cast in a suitable manner, they were entirely free from inter-dendritic shrinkage. Incidentally, the casting of gear blanks was difficult, but when once they were obtained sound and dense, there was no trouble whatsoever in hardening a 1¼-in. section right through to the middle, so that it would exhibit properties very similar to those of the standard test-pieces. In a large blank, 8 in. in diameter and 1½ in. thick, there had been little difficulty in achieving in the actual casting a tensile strength of about 36 tons per sq. in., and a Brinell hardness of about 170. It was perhaps a little premature to say much about that at the moment, but those results had been actually obtained in this country.

With regard to the Lepp process, he said he did not think that anybody knew the true function of the fluid slag, and when one used those oxidising slags, there was no doubt that the metal produced was infinitely sounder than it would be otherwise. His own theory was that, by using a fluid slag containing oxides, there was effected a reaction between the slag and the metal, provided the slag was of a certain composition. As in the laboratory one could obtain a definite reaction between two liquids, so in the use of a fluid slag one could effect a chemical reaction between it and the metal, very similar to that occurring in the refining of steel. In certain oxidising furnaces, such as the high-frequency furnace, a thin film of slag was formed on the surface, due to the action of oxygen in the air, and he believed that that worked on similar lines to those which applied when a synthetic slag was produced on top of the metal.

Dealing with Mr. Cartland's reference to the difference between porosity of the blowhole type and inter-dendritic shrinkage, he said that the two types of porosity were definitely due to the same cause, but to a varying degree. In extremely gassy metal, blowholes would most probably occur, varying in size from that of a pin

point to a diameter of half an inch in many instances. On the other hand, where there was a partly completed reaction and there was only a small amount of gas present, gas coming out of solution as the metal solidified was one of the principal causes of inter-dendritic shrinkage.

Replying to Mr. Watson's question as to whether some of the suggestions made in the Paper could be applied to the ordinary brass alloys, he said he was quite confident that they could. Some people might be rather sceptical about using a heavily oxidising slag on a brass, from the point of view that excessive zinc losses might be anticipated; but actually that did not happen. While the slag was on the metal, although there was an oxidising reaction, there was no zinc coming off the metal, and the oxidising conditions would definitely eliminate some of the detrimental gases. He had seen some very excellent results obtained when using oxidising conditions for melting brass. Indeed, he would go so far as to say that in the case of nickel silver, which was basically a brass but was infinitely more susceptible to gas absorption, in order to guarantee results it was almost essential to use an oxidising slag of some kind. In many instances, however, he felt that the zinc in the brass was a natural de-oxidiser, and that there was no need to de-oxidise the brass after the oxidation treatment.

Whilst discussing the treatment of brass he mentioned that in his experience, in connection with manganese-bronze, an improvement was obtained by the use of soda ash, particularly when a high percentage of scrap was used in the mixture. No doubt Mr. Watson had seen at times the peculiar fracture of manganese-bronze showing porous areas with black specks in the middle of them; in his own experience he had seen those areas practically eliminated by soda-ash treatment.

It was particularly pleasing to have Mr. Logan's confirmation of the opening comments in the Paper, because Mr. Logan had been a colleague of his on Tyneside.

On the subject of oxides, mentioned by Mr. Newson, but little was known. Possibly there was more than one type of oxide. There were probably "active" and "inactive" oxides. If metal contained inactive oxides, then there was no need to de-oxidise; but if it contained oxides of the active type, then it was more or less essential to render them inactive by de-oxidation treatment. The view with regard to active and inactive types of oxides was only surmise, and future research would have to determine the true story.

Vote of Thanks

Mr. G. C. Pierce (Past-President of the London Branch of the Institute of British Foundrymen) proposed a very hearty vote of thanks to Mr. Hudson for his splendid Paper.

Mr. A. J. Murphy, seconding, described the Paper as magnificent; as a member of the Institute of British Foundrymen and the Institute of Metals, he was proud as a host and grateful as a guest. He was rather disappointed that the discussion had been so short, but Mr. Hudson could be assured that he need have no misgivings on that account regarding the keenness of the interest displayed in his Paper. A good many experiments would be made by those who had been present, stimulated by some of the new thoughts which Mr. Hudson had put forward in his Paper.

The Chairman (Mr. Barrington Hooper) supported the vote of thanks. Expressing agreement with Mr. Hudson's reference to the need for appointing a metallurgist in every foundry, he said that on many occasions he had wished that he had had a metallurgist with him, so that he could have transferred the blame for the results of his labours! Seriously, however, on the question as to why the non-ferrous section of the industry appeared to be so backward, he wondered how many had studied the census of foundries that had been published in the Foundry Trade Journal* a short time ago, and how many had noticed that there were 167 non-ferrous foundries in the London and district area. Most people in the industry knew the reputable and responsible foundries in, say, South-East England; but he asked them to try to imagine what some of the 167 were like. It was all a question of economics, and many who had had to put up with the competition of some of them appreciated where the trouble arose. The existence of so many was undoubtedly one of the causes of lack of progress.

He thanked Mr. Hudson not only for the Paper he had presented to that meeting, but also for his earlier Papers, which had been of great interest and which had been amplified from time to time.

The vote of thanks was carried with acclamation.

Mr. Hudson, in a brief response, urged that the best way in which to meet competition was to employ a metallurgist, because a metallurgist in a foundry would probably cut melting costs and improve production, and increased efficiency as a whole.

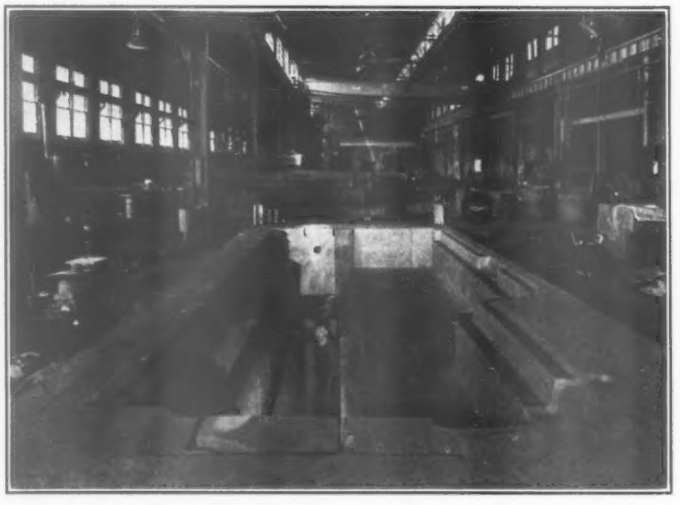
* "Some Notes on the Structure of the Foundry Industry of the United Kingdom," by V. C. Faulkner, Vol. 59, p. 249.

American Notes

A Massive Steel-Mix Milling-Machine Casting

Requiring 65 days' actual time in the manufacture, the largest steel-mix casting ever made in the Chicago area was recently delivered to the Rockford plant of Ingersoll Milling Machine Company by the Tarrant Foundry Company, Chicago. The casting weighed about 38 tons, and is a part of a huge milling machine for machining die-blocks. Some time ago a 26-ton bed for the same job was cast and despatched. The size of the casting was 22 ft. long by 10 ft. wide and 12 ft. deep. Water seepage being one of the principal problems in the moulding of this job, the precautionary step of making a fairly large construction job was undertaken, and a concrete pit 14 ft. by 30 ft. by 60 ft. was constructed. More than 40 tons of molten metal were poured into the mould. The making of the job and the finished casting are shown in the accompanying illustrations.

Steel-Mix Casting for Milling Machine, made by Tarrant Foundry Company, Chicago. It weighs 38 tons.



Reinforced-Concrete Waterproof Pit built for Moulding of Large Milling-Machine Casting in the Tarrant Foundry.

The Yorkshire Electric Power Company is to proceed immediately with plans for a new electric power station at Mexborough at an estimated cost of £1,000,000.

Porosity and Sinking in Cast Iron*

SOME NEW EXPERIMENTAL EVIDENCE

By W. WEST and C. C. HODGSON (Leyland Motors, Limited)

It is now generally recognised that the very marked progress in the physical properties of cast iron has been brought about by a better and more searching examination of its composition and structure. If it were possible always to keep a well-balanced eutectic mixture for each type of casting commercially produced, less trouble from internal porosity and external sinking in iron castings would be experienced by founders. Most foundries have developed their own technique to suit the multifarious types of castings produced; practical obstacles, many of which are obvious and in the main locked up with this individual technique, make it impossible to select an iron of eutectic mixture to meet all requirements. In spite of this fact, some of the peculiar effects experienced which make their contribution to the defective scrap pile are common to all foundries. Internal porosity in heavier sections adjoining thinner ones is still sufficiently common to be a nuisance. The use of certain kinds of pig-iron may contribute largely to this phenomenon or to external sinking in remote corners where sections meet.

External sinking of castings is much more frequent since the practice of lowering the total carbon by the addition of steel has been followed in order to produce high-strength iron in particular. This result is not altogether unexpected when the decrease in total carbon reaches a certain point, but when external sinking takes place with cast iron having an average content of 3½ per cent. total carbon, and then only with particular brands of raw material, some investigation is called for, and in the authors' case actual observations of this sort commenced these experiments.

In the first instance, external sinking occurred more or less suddenly, coinciding with the use of a particular brand of pig-iron. A change of raw material from A and B to D and E (Table I) brought the relief required, though at a later stage the reproduction of this sinking effect could not be accomplished at will. Such an incident occurs frequently in all foundries, but the means of the relief from the trouble leaves a very unsettled and unsatisfactory state of mind. It was decided, therefore, to pursue the problem in search of a satisfactory solution. The castings under question were made in moulds from hand-press machines and the moulds in turn were poured from metal melted in an orthodox way in the cupola.

Originally it was thought that the sinking effect was associated with the pig-iron used, or the sand moulds and the particular method of making them. The change of raw material which brought about the elimination of the sinking was rather misleading. It was known that between the two sets of pig-iron there was little difference in chemical composition, except

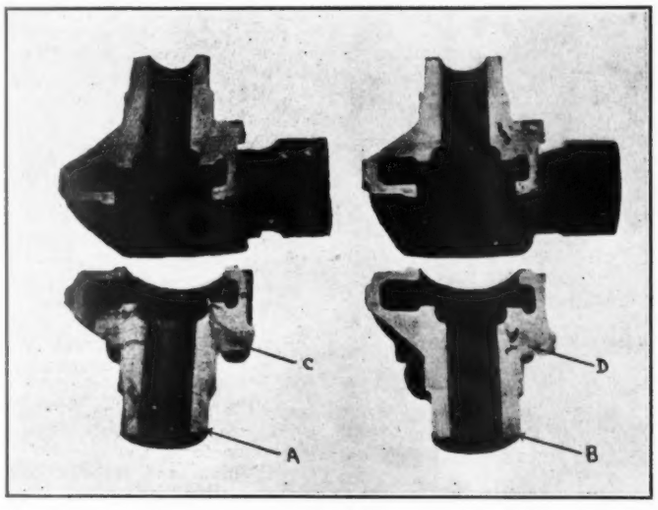


Fig. 1.—Pump-body Casting Sawn into Two. Left: Sound. Right: Porous in Thick Section, and (not shown) Sunken in Boss.

Table I.—*Analysis of Typical Examples of Pig-Iron Used.*

Pig mark.	C.	Si.	Mn.	S.	P.	Cr.	Ti.
A.	3.75	3.56	0.99	0.014	0.16	0.03	0.12
B.	4.17	1.63	1.09	0.018	0.16	0.03	0.08
C.	3.00	2.38	1.06	—	0.30	2.71	—
	3.00	2.00	1.00	0.07	0.33	3.16	0.03
D.	4.26	1.72	1.10	0.020	0.27	0.03	0.19
	4.21	1.85	1.49	0.020	0.19	0.02	0.17
E.	3.76	3.02	0.53	0.018	0.06	0.01	0.03
F.	2.77	2.04	1.00	0.033	0.22	0.36	—
	2.86	2.08	1.05	0.030	0.27	0.28	—
G.	2.76	2.12	1.19	0.06	0.05	—	—
	2.78	2.18	1.38	0.05	0.07	—	—
H.	2.73	2.04	1.04	0.104	0.10	0.03	0.02
	2.69	2.04	1.12	0.100	0.09	0.04	0.02
J.	2.24	1.89	0.87	0.088	0.20	0.03	0.02
	2.04	1.84	0.98	0.090	0.23	0.03	0.02
Ferro-silicon titanium	—	14	—	—	—	—	20

Table II.—*Water-Pump Body Casting, Weight* 10 *Lbs.* (See Fig. 1).

Sound casting.	Drawn casting, external sink near base of boss, shrinkage cavity inside boss when cut up.	Sound casting.
Mixture— (For average analyses of pig-irons, see Table I)		
Pig A. 1 cwt.	Pig A. 2 cwt.	Pig C. ½ cwt.
Pig B. 2½ ,,	Pig B. 5 ,,	Pig D. 4½ ,,
Soft scrap 1½ ,,	Soft scrap 3 ,,	Pig E. 2 ,, Soft scrap 3 ,,
Method of Melting—		
In small experimental cupola.	In large production cupola.	In large production cupola.
Chemical Composition— Reference No.		
M. 2336	M. 2337.	M. 2347.
C 3.84	3.82	3.78
Si 1.97	2.08	2.06
Mn 0.77	0.67	0.94
S 0.080	0.104	0.084
P 0.16	0.22	0.21
Ni 0.10	0.02	0.05
Cr 0.10	Nil	0.33
Ti 0.04	0.05	0.08
V Nil	Nil	0.02
Mo 0.04	0.04	0.02
Sn 0.03	0.03	0.01
Al 0.04	0.03	0.03
Cu 0.06	0.02	0.02

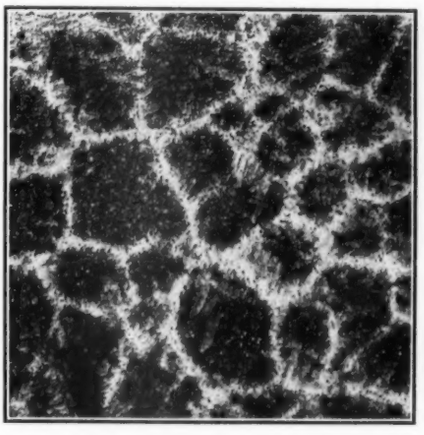


Fig. 2.—Microstructure at Position A, Fig. 1. × 50.

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. H. V. Grundy presiding.

for a larger amount of titanium in one of them. In pursuance of the effect of titanium, experiments were carried out by making additions of ferro-silicon-titanium and treating in a crucible furnace, the results of which are recorded later.

Titanium Treatment

The credit for the pioneer study of graphite formation and its relation to titanium treatment should in the first place be given to the British Cast Iron Research Association, because

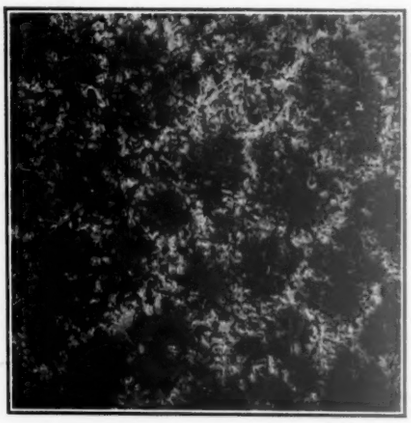


Fig. 3.—Microstructure at Position B, Fig. 1. × 50.

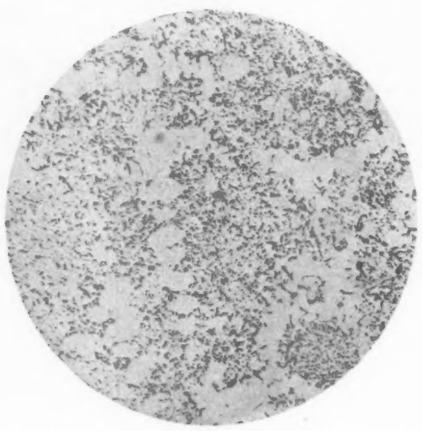


Fig. 4.—Microstructure at Position A, Fig. 1. Unetched. × 100.

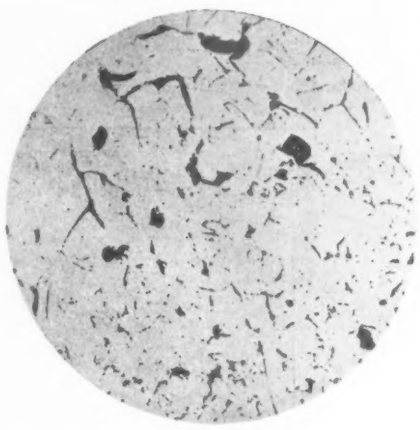


Fig. 5.—Microstructure at Position B, Fig. 1. Unetched. × 100.

the published work of this Association gave the initial encouragement to the authors to attempt the more practical interpretation of their results with particular designs under foundry conditions.

As a short summary of the work of the Association, it might be helpful to note that by a special treatment of molten iron the conventional type of flake graphite can be changed at will throughout the mass to the finest form of distribution which graphite is capable of taking. This process is covered by British and foreign patents.

The process consists of treating molten cast iron containing about 0.2 per cent. titanium with carbon dioxide for a short period. Two outstanding advantages are obtained from this treatment. First, there is its direct effect upon the mechanical properties of the cast iron by increasing the tensile and transverse strengths. Examples are quoted by the Association wherein the transverse strength of hematite iron, as a result of the titanium and carbon-dioxide treatment, was raised from 17.4 tons to 30.3 tons per sq. in. on a 3-in. test-bar, and a corresponding improvement in the tensile strength from 7.5 tons to 19.5 tons per sq. in. was obtained with the same diameter test-piece.

One of the features of the process is that it may be applied to irons irrespective of carbon content, provided that, as in most cast irons, the eutectic carbon figure is not exceeded. In relatively high-carbon irons the coarseness of the graphite when in the flake condition makes these irons relatively weak, and hence the gain by transforming to the fine graphite condition is proportionately great. As the carbon content of the iron decreases, the gain on transformation is naturally reduced.

Secondly, the titanium treatment assists in the production of castings which are dense and free from internal porosities, which otherwise might be difficult to manufacture without such deficiencies. A further feature of the refining treatment is the uniformity in the structure of the sections, making it possible to cast sections exceeding 6 in. thick with a uniformly close grain throughout the section. It is also stated that melts containing titanium appear to have a greater degree of "life" when molten than cast irons which have not received the treatment.

Fig. 6.—Microstructure at Position C, Fig. 1. Etched. × 100. Junction of Three Cell Boundaries.

Fig. 7.—Microstructure at Position C, Fig. 1. Etched. × 100. No Cell Walls in Evidence.

Fig. 8.—Microstructure at Position D, Fig. 1. Unetched. × 100.

Theory of the Treatment

The theory of such reactions from the treatment appears to be a very debatable point. Boyles* believes that the real action of carbon dioxide in the treatment is to free the melt of hydrogen. In this summary, however, it is not the authors' intention to pursue the theoretical reasons, but to state the opinions of the workers of the Association. In this connection, they suggest that the form of graphite distribution depends upon the composition of the iron, the speed of cooling, and, most important of all, on the nature and distribution of the inclusions present in the melt. Small crystalline inclusions act as nuclei which inoculate the melt and thus cause crystallisation to take place with very little under-cooling. These inclusions, they think, are effective only while they are in the crystalline form, and suggest that the effect of the titanium and carbon-dioxide treatment is that the titanium is made to form a fluid slag, which covers or combines with the solid silicate particles to form combinations which are liquid externally, when the graphite separates out, and that, being liquid, they do not act as inoculants, and super-cooling occurs which produces fine graphite.

Whatever the true explanation be for this finely distributed or super-cooled graphite formation, it is acknowledged by those who have worked upon the problem that the conditions under which melting and treatment take place are all-important. For example, the production of modified graphite at will is comparatively easy when the cast iron is melted and treated in a crucible furnace, but more difficult in the cupola, although the authors have been informed by the Association that it is now possible to produce supercooled graphite structures in cupola-melted irons if certain precautions are observed in melting.

* Trans. A.I.M.E., Iron and Steel Div., T.P. 809, 1927.

Test-Bars.—These were 0.875 in. dia., cast in discuss the results here in detail item by item,

It has been observed by most ironfounders that mixed structures of flaky and supercooled graphite have occurred in certain types of commercial castings made from the cupola, chiefly at the extreme edges of the casting. These mixed structures may have been produced by the presence of titanium which is contained in varying amounts in many British pig-irons, and that complete modification of the graphite form had not taken place because of the absence of an oxidising treatment in the molten condition. Experiments carried out by the Association proved that a titanium-bearing mixture which is readily modified by carbon dioxide when crucible-melted may not respond to the treatment when cupola-melted.

Several conditions contributing to cupola melting have since been investigated, and a general review indicates that the cupola coke may be regarded as a vehicle for the introduction of inclusions into molten cast iron. The presence of sulphur is not harmful to the titanium process.

The authors, however, thought that the modification to the structure of cast iron might have some further value to the foundryman, and they decided to carry out experiments under their own foundry conditions.

These experiments did not, however, give them a direct relation with the major problem of sinking. It was, therefore, decided to give attention to the sand and its condition. Certain physical characteristics were determined, such as permeability, moisture content, clay and coal-dust contents, and also the effect of a dry condition of the mould. A full account of the details of the experiments is now given with such explanations as the results permit.

Examination of Specimen Castings

The first step in the investigation was to carry out a metallurgical examination of specimen castings. Three castings made from the same pattern and of known history were available. They are detailed in Table II.

Table III.—*Details of Melting, Treatments, and Casting Temperature.*

Series 1.	Series 2.	Series 3.	Series 4.	Series 5.
Charges—				
Pig A. 1¾ cwt. Pig B. 2½ cwt.	Pig D. 1¾ cwt. Pig E. 1 „ Pig C ¼ „ Soft scrap 1¼ „	Pig A. 1¼ cwt. Pig B. 3 „	Pig A. 1 cwt. Pig B. 7 „	Pig A. 1¼ cwt. Pig B. 3 „
Method of melting—				
Oil-fired crucible	Oil-fired crucible	Oil-fired crucible	Cupola	Oil-fired crucible
Casting temperature and additional treatment—				
1/1 1,380 deg. C. heating.	2/1 1,370 deg. C. heating.	Treated with 11 lbs. of Fe-Si-Ti. Steel for container 5½ lbs. 3/1, 1,415 deg. C. (heating).	4/1 1,420 deg. C.	5/1 1,300 deg. C.
1/2 1,420 deg. C. heating.	2/2 1,420 deg. C. heating.	3/2 1,430 deg. C. heating.	4/2, 5 cwt. transferred to crucible of oil-fired furnace and treated with 12 lbs. Fe-Si-Ti. 1,280 deg. C.	5/2 treated with 11-lbs. Fe-Si-Ti. 1,320 deg. C.
1/3 1,460 deg. C.	2/3 1,440 deg. C.	3/3 1,440 deg. C.	4/3. As 4/2 treated for 2½ mins. with CO_2. 1,310 deg. C.	5/3 treated with CO_2 for 2 mins. 1,310 deg. C.
1/4 1,430 deg. C. cooling.	2/4 1,360 deg. C. cooling.	3/4 1,400 deg. C. cooling.	4/4 As 4/3 after allowing to cool in shank. 1,240 deg. C.	
1/5 1,390 deg. C. cooling.	2/5 1,300 deg. C. cooling.	3/5 1,330 deg. C. cooling.		

Table IV.—*Chemical Composition of the Castings made during Part I of the Investigation.*

Per cent.	C.	Si.	Mn.	S.	P.	Cr.	Ti.
Series 1 ..	3.74	2.18	1.09	0.028	0.138	0.03	0.07
Series 2 ..	3.82	2.10	0.92	0.040	0.184	0.26	0.08
Series 3/1 ..	3.82	2.00	0.98	0.026	0.15	0.02	0.17
3/2 ..		2.20					0.38
3/3 ..		2.24					0.38
3/4 ..		2.22					0.36
3/5 ..	3.70	2.22			0.16		0.36
Series 4/1 ..	3.87	2.10	0.94	0.068	0.12	0.03	0.07
4/2 ..	3.79	2.14					0.19
4/3 ..	3.70	2.30					0.42
Series 5/1 ..	3.92	1.89	0.87	0.035	0.16	0.03	0.06
5/2 ..	3.76	2.09					0.33
5/3 ..	3.72	2.13					0.44
5/4 ..	Not analysed						

Microscopic Examination

Sections were cut from the thin and thick portions of the castings. The micro-structures of the two sound castings were very similar and only one set will be described; the following descriptions refer to the first and second castings above (Ref. M. 2336, M. 2337, *i.e.*, those made from similar mixtures).

Sound casting (thin section A, Fig. 1) and unsound casting (thin section B, Fig. 1).—At low magnification (50 diameters), the etched specimens show cell walls consisting of pearlite with some phosphide eutectic. This is more clearly marked in the sound casting (Fig. 2) than in the unsound (Fig. 3). The graphite in section A is mainly of the super-cooled type (Fig. 4), with a considerable amount of ferrite separated; some of the pearlite is well laminated, but much of it is too fine to be resolved with a 3-mm. objective. In section B there is a little super-cooled graphite near the surface, but it quickly coarsens until, at a little distance from the surface, it exists in fine to medium flake form (Fig. 5); the pearlite is well laminated. The outer corners of section A show what appears to be chilling, but on examination at high magnification the white portions turn out to be ferrite (there are traces of cementite); the dendritic cementite originally formed has evidently decomposed during cooling into fine graphite and ferrite. In B the chilling effect noted in A is absent.

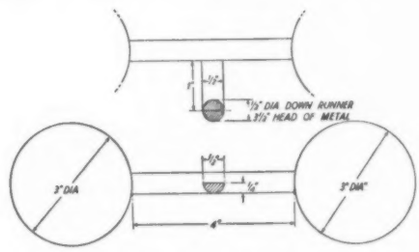


Fig. 9.—B.C.I.R.A. Dumb-bell Type Test-Piece for Shrinkage and Porosity Tests.

Sound casting (thick section C, Fig. 1) and unsound casting (thick section D, Fig. 1).—The pearlite cell walls are still in evidence in some parts of sections C (Fig. 6), in others they are missing (Fig. 7); there is a considerable variation in graphite size. In section D, the ghost network has disappeared entirely and the graphite is present as very large flakes (Fig. 8).

From this short summary it will be seen that the chief differences between the sound and the unsound castings appear to be the size of the graphite flakes and the distribution of the phosphide.

Experimental

The experimental work has been divided into two sections. Part I deals with the relation-

Table V.—*Mechanical Properties, Series 1.*

Chemical Composition: C, 3.74; Si, 2.18; Mn, 1.09; S, 0.028; P, 0.138; Cr, 0.03 and Ti, 0.07 per cent. Test-bars nominal size 0.875 in. dia. cast in oil-sand moulds.

Expt.	Casting temp. Deg. C.	Transverse on 12-in. centres, tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per sq. in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.
1	1,380 heating	0.875	1,120	1,120	22.8	0.18	12.32
		0.875	1,098	1,098	22.36	0.18	12.00
2	1,420 heating	0.890	1,120	1,064	21.67	0.19	11.20
		0.895	1,210	1,131	23.02	0.22	11.20
3	1,460	0.90	1,187	1,090	22.22	0.22	9.24
		0.89	1,053	1,000	20.37	0.20	9.36
4	1,430 cooling	0.89	1,232	1,170	23.83	0.18	10.2
		0.87	1,030	1,048	21.33	0.17	10.16
5		No test-bars cast.					

Table VIII.—*Mechanical Properties, Series 4.*

peratures varying by more than 100 deg. C. The

ship between metal and soundness, and Part II with that between sand and soundness. In describing the results of Part I, attention will be directed first to mechanical properties, then to a consideration of shrinkage spheres, and finally to the castings for the sake of continuity with Part II.

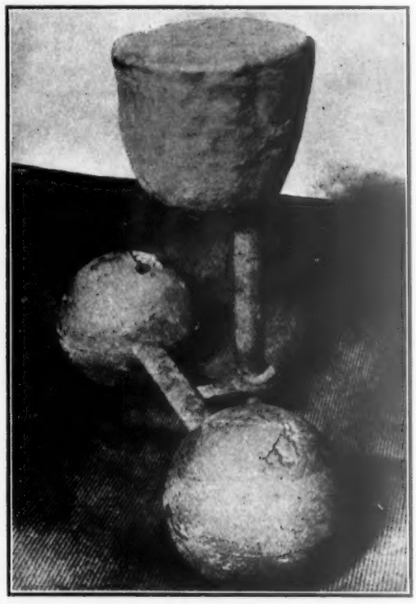


Fig. 10.—B.C.I.R.A. Test Spheres.

PART I.—RELATIONSHIP BETWEEN METAL AND SOUNDNESS

In this series of experiments, pump bodies similar in design and size to those shown in Fig. 1 were used as the test castings, and some additional experiments on stabilus bodies similar to Fig. 19. In addition, shrinkage spheres similar to those used by the B.C.I.R.A. (see Figs. 9 and 10) and transverse test-bars 0.875 in. dia. were cast, the details of which (see Fig. 11) are as follow:—

Pump Body Castings.—Moulded in green sand on hand-press machines, two per box using one common runner; two boxes cast for each experiment.

Shrinkage Spheres.—Moulded in green sand on hand-press machines, spheres 3 in. dia. joined by a runner ½ in. dia., this in turn being fed by one of D section of ¼ in. radius; the head of molten metal was 3½ in.

Test-Bars.—These were 0.875 in. dia., cast in oil sand (and in some instances a similar set hand-rammed in green sand).

All the castings (except test-bars) discussed in Part I were cast in green sand made up as follows:—Mansfield sand, 7 parts; used sand, 23 parts, and coal-dust, 10 lbs. per 4 cwts. of sand mixture. This sand gives the following average tests:—Moisture, 5.8 per cent.; green permeability, 125 secs.; green compression, 9.5 lbs. per sq. in., and loss on ignition, 5.7 per cent.

Table VI.—*Mechanical Properties, Series* 2.

Chemical Composition: C, 3.82; Si, 2.10; Mn, 0.92; S, 0.040; P, 0.184; Cr, 0.26; and Ti, 0.08 per cent.
Test-bars nominal size, 0.875 in. dia., cast in oil-sand moulds.

Expt.	Casting temp. Deg. C.	Transverse on 12-in. centres, tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per sq. in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.
1	1,370 heating	0.875	1,456	1,456	29.64	0.19	13.2
		0.880	1,344	1,321	26.89	0.16	12.72
2	1,420 heating	0.845	1,165	1,293	26.33	0.19	13.72
		0.880	1,344	1,321	26.89	0.17	13.6
3	1,440	0.855	1,255	1,345	27.38	0.14	13.4
		0.865	1,456	1,507	30.68	0.15	12.8
4	1,360 cooling	0.850	1,299	1,418	28.86	0.14	14.16
		0.860	1,478	1,556	31.69	0.16	14.08
5	1,300 cooling	0.865	1,456	1,507	31.39	0.15	13.92
		0.860	1,344	1,416	29.49	0.16	13.8

Table VII.—*Mechanical Properties, Series* 3.

Test-bars nominal size 0.875 in. dia. cast in oil-sand moulds.

Expt.	Casting temp. Deg. C.	Transverse on 12 in. centres, tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per sq. in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.	Analysis. Si.	Ti.
1	1,415 heating	0.870	1,523	1,550	31.55	0.16	15.72 / 15.80	2.00	0.17
2	1,430 heating	0.865	1,568	1,623	33.05	0.17	15.4	2.20	0.38
		0.870	1,523	1,550	31.55	0.19	15.4		
3	1,440	0.865	1,456	1,507	30.68	0.17	15.8	2.24	0.38
		0.865	1,456	1,507	30.68	0.16	15.8		
4	1,400 cooling	0.865	1,456	1.507	30.68	0.17	15.8	2.22	0.36
		0.870	1,523	1,550	31.55	0.19	15.8		
5	1,330	0.870	1,568	1,595	32.48	0.17	15.2	2.22	0.36

Details of charges, method of melting, addition treatment and casting temperature will be found in Table III. Analyses of the pig-irons and ferro-silicon-titanium are given in Table I. The ferro-silicon-titanium was packed into a steel canister attached to a steel rod protected by a graphite sleeve. The steel rod was provided with a ring by means of which it could be attached to the crane hook and lowered into the crucible; a weight on the rod enabled the canister to be kept immersed in the molten iron, shown diagrammatically in Fig. 12. In all experiments in this series, treatment with ferro-silicon-titanium and with carbon dioxide took place in the crucible. Some difficulty was experienced in obtaining thorough mixing of the metal in the crucible after the addition of the ferro-silicon-titanium, with the result that there was a gradual increase in the silicon and titanium contents of the treated members of series 3, 4 and 5; details of these variations are given in Table IV. Temperatures were measured with a platinum/platinum-rhodium thermo-couple encased in a fused silica sheath protected with a refractory wash.

A full examination was made of the various specimens obtained, but it would be wearisome to discuss the results here in detail item by item, the complete results are included in Tables III *et seq.* The salient features may be summarised as follows:—

Mechanical Properties

Throughout the experiments, all mechanical properties refer to results obtained from test-bars cast to a nominal size of 0.875 in. dia. All tests were made in duplicate, and in general there was fairly good agreement between the duplicate tests. A large number of mechanical tests have been made, but with the exception of a few additional examples where necessary, only those referring to Series 1 to 5 will be given.

The results of the tests made in Series 1 and 2 are given in Tables V and VI. The mechanical properties of the metal of Series 1 were considerably influenced by casting temperature, whereas those of Series 2 show very little variation over a similar range of temperature. The authors believe this to be due to the form and distribution of the graphite which existed as flakes, increasing in size with the casting temperature in Series 1, and mainly as fine graphite in Series 2.

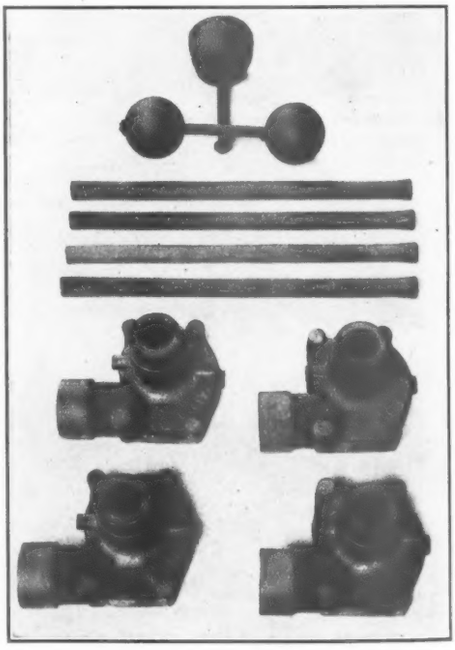


Fig. 11.—Set of Test Castings.

The mechanical properties of Series 3 show remarkable uniformity over a range of casting tem-

Table VIII.—*Mechanical Properties, Series 4.*
Test-bars nominal size 0.875 in. dia. cast in oil-sand moulds.

Expt.	Casting temp. Deg. C.	Transverse 12-in. centres tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per per in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.	Analysis. C.	Si.	Ti.
1	1,420	0.90	1,187	1,091	22.20	0.24	9.68	3.87	2.10	0.07
		0.90	1,164	1,070	21.78	0.26	9.68			
2	1,280 Ti treated	0.89	1,523	1,447	29.39	0.21	15.52	3.79	2.14	0.19
		0.90	1,680	1,543	31.41	0.17	15.36			
3	1,310 CO_2 treated	0.89	1,568	1,489	30.26	0.20	15.00	3.70	2.30	0.42
		0.90	1,612	1,482	30.16	0.20	15.20			
4	1,240 CO_2 treated and cooled	0.90	1,500	1,379	28.05	0.19	13.12			
		0.89	1,478	1,404	28.53	0.21	13.20			

Table IX.—*Mechanical Properties, Series 5.*
Test-bars nominal size 0.875 in. dia. cast in oil-sand moulds.

Expt.	Casting temp. Deg. C.	Transverse 12-in. centres tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per per in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.	Analysis. C.	Si.	Ti.
1	1,300	0.92	1,232	1,059	21.46	0.13	10.88	3.92	1.89	0.06
		0.90	1,187	1,091	22.20	0.15	10.88			
2	1,320 Ti treated	0.90	1,657	1,523	30.99	0.14	14.28	3.76	2.09	0.33
		0.90	1,568	1,441	29.32	0.17	14.28			
3	1,310 CO_2 treated	0.89	1,657	1,574	31.99	0.15	14.40	3.72	2.13	0.44
		0.875	1,545	1,545	31.53	0.14	15.20			

Table X.—*Influence of Titanium Treatment on Cupola-Melted Iron.*

	Mould.	Transverse 12-in. centres. Tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per sq. in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.
Cupola metal. Cast 1,350 deg. C. Ref. M.2441	Green sand	0.875	1,187	1,187	24.22	0.17	10.32
		0.89	1,187	1,120	22.92	0.19	9.96
Do.	Oil sand ..	0.88	1,210	1,187	24.18	0.17	10.12
		0.895	1,232	1,142	23.41	0.17	10.04
As above, crucible treated with Fe-Si-Ti. Cast 1,360 deg. C. Ref. M.2442	Green sand	0.875	1,680	1,680	34.27	0.15	16.40
		0.875	1,344	1,344	27.42*	0.13	16.84
Do.	Oil sand ..	0.91	1,837	1,635	33.24	0.18	15.68
		0.88	1,568	1,545	31.35	0.17	15.28

Chemical composition :—

	C.	Si.	Mn.	S.	P.	Cr.	Ti.
M.2441	3.75	1.80	0.82	0.072	0.14	0.06	0.07
M.2442	3.71	1.96	0.82	0.080	0.13	0.06	0.35

Cupola charge :— Pig A. 1½ cwts.
Pig B. 3 cwts.
* Test-piece unsound at surface.

Table XI.—*Influence of Titanium Treatment on Cupola-Melted Iron.*

	Casting temp. Deg. C.	Transverse 12-in. centres. Tested without machining. Dia. of bar. In.	Breaking load. Lbs.	Corrected breaking load. Lbs.	Modulus of rupture. Tons per sq. in.	Deflection. In.	Tensile machined to 0.564 in. dia. M.S. Tons per sq. in.
Cupola metal. Ref. M.2382	1,340	0.92	1,277	1,098	22.4	0.24	11.60
		0.91	1,254	1,115	22.74	0.25	11.36
As above, crucible treated with Fe-Si-Ti. Ref. M.2383	1,320	0.875	1,501	1,501	30.62	0.24	14.4
		0.88	1,546	1,502	31.00	0.24	14.0

	C.	Si.	Mn.	S.	P.	Cr.	Ti.
M.2382	3.78	1.94	0.97	0.068	0.195	0.26	0.08
M.2383	3.75	2.06	1.00	0.068	0.190	0.26	0.28

Cupola charge :—Pig C, ½ cwt.; pig E, 1½ cwt.; pig F, 5 cwts.; and soft scrap, 3 cwts.

peratures varying by more than 100 deg. C. The graphite in these specimens was wholely of the super-cooled variety. The mixture and method of melting are the same as used for Series 1 (which gave rather poor results), and the improvement is to be attributed entirely to the change in structure brought about by the treatment with ferro-silicon-titanium (Table VII).

In Series 4 and 5, treatment with carbon dioxide was used additional to treatment with titanium, and the results (Tables VIII and IX) show that under the conditions of these experiments, no notable improvement was obtained by using CO_2. These experiments were also intended to show the influence of the method of melting, but unfortunately the disparity between the casting temperatures of the

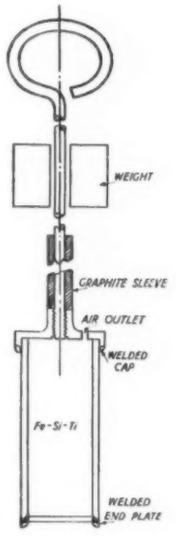


Fig. 12.—Arrangement Steel Canister containing Ferro-Silicon-for Immersion of Titanium.

untreated metal in the two series, and between the untreated and treated metal in Series 4, renders such a comparison impossible. The authors have, however, ample proof that titanium treatment brings about equally good results whether the metal is melted in the cupola or the crucible, and they offer the results shown in Tables X and XI as evidence of this, the titanium treatment in each instance being carried out in the crucible. It may be mentioned here that very little improvement has been found when applying the titanium treatment to cast irons which in their normal condition possess good mechanical properties, say of the order of 17 or more tons per sq. in. maximum stress in tensile.

(To be continued.)

Danish Steel Foundries

Virtually without such raw materials as iron ore, coal and water power, Denmark has three steel foundries. Burmeister & Wain, Copenhagen, shipbuilders, have two open-hearth furnaces and produce, primarily, for their own requirements. A/S. Frichs, Aarhus, a large machinery and engineering plant, operate two Bessemer converters, again chiefly to meet their own needs. Varde Staalvaerk, Varde, also have two Siemens-Martin furnaces, but unlike the other firms produce a general line of castings for sale. The furnaces in these three plants are stated to range between 20 and 30 tons capacity each. Danish official statistics report that in 1937 all local shipbuilding plants produced about 100,000 tons of castings.

Institute of British Foundrymen

BRANCH ANNUAL MEETINGS IN LANCASHIRE AND LONDON

LANCASHIRE BRANCH

The annual meeting of the Lancashire Branch of the Institute of British Foundrymen was held in the Engineers' Club, Manchester, on Saturday, April 1, Mr. H. V. Grundy presiding.

Hon. Secretary's Report

The Hon. Secretary, MR. J. E. COOKE, in presenting his Annual Report, stated that Branch activities had been maintained at a high level, in spite of unusually difficult conditions, and the business of the Institute had also made heavy demands upon the time and attention of the Branch representatives.

The statement of accounts showed increased expenditure due to unexpected commitments, and membership had also been slightly affected, a decrease of six members being registered during the year. The total at December 31, 1938, was 370.

Sectional Activity

The Burnley Section had had another successful year and had conducted its affairs efficiently with decreased expense. The Junior Section had been poorly supported by its members, and it had been decided to close down its independent activities by April 30. The question of securing and maintaining the interest of students and young foundrymen still engaged the attention of the Branch Council.

The annual outing to Dovedale on July 2 was a very pleasant one, and 46 people spent a very happy day together.

Social Events

The visit to Glasgow Exhibition and to the extensive foundries of Harland & Wolff was well supported, 86 people taking part. The co-operation of the Scottish Branch members was a very pleasing feature, and the members of that Branch brought the strength of the party up to about 100.

Attendance at the social evening following the opening meeting in October was affected by the prevailing international disruption, but the 46 members and friends made up in enjoyment what they lacked in numbers.

The annual dinner was a very successful and enjoyable one, and the 220 people present would remember it with pleasure.

The winter-syllabus handbook was again a very satisfactory result of the labours of the Publication Committee, and the winter series of lectures had been well attended, in spite of programme disorganisation due to illnesses of lecturers. The average attendance had only been slightly lower than usual. A propaganda meeting in Liverpool was only a moderate success, but it might be worth repeating.

The National Committee responsible for organising the International Congress, to be held in London in June next, had worked out a most interesting programme. The Reception Committee of the Lancashire Branch had arrangements well in hand for the arrival of the visitors to Manchester during the Post-Congress Tour. An appeal for financial support in this connection would be made during the next few days.

Awards

The competition open to Lancashire members for a Paper on foundry practice produced two satisfactory entries among others, the first prize (a gold medal) being awarded to Mr. J. Laing for "Gating and Pouring in a Non-Ferrous Foundry," and a silver medal as second prize to Mr. R. S. Turner for "Runners and Risers." The Paper by Mr. Laing was to be used as an Exchange Paper in joint arrangements made with the South African Branch of the Institute.

The Diploma of the Institute had again been awarded to two members who had presented Papers before the Lancashire Branch, Mr. A. Phillips and Mr. J. G. Rees receiving these awards.

In conclusion, Mr. Cooke stated that the series of reports which it had been his privilege to present to the members was now terminated. Those reports had summarised work which it had been a pleasure for him to do on account of the goodwill and comradeship of the whole of the members, and particularly of his colleagues on the Branch Council and at the General Office.

Upon the motion of Mr. R. A. Jones, seconded by Mr. J. Hogg, the hon. secretary's report was unanimously approved and adopted.

Vote of Thanks to Retiring Officers

MR. J. JACKSON, in proposing a hearty vote of thanks to the retiring President and officers of the Branch, said they all knew how well Mr. Grundy had filled the office of President and had added dignity and lustre to it. The hon. secretary, Mr. J. E. Cooke, was also leaving his post. The Lancashire Branch had probably never at any time had an hon. secretary who was more generally respected by the whole of the members than was Mr. Cooke. In fact, the Council felt that his services were of such value to the Branch that they ought to keep him in close contact with it, and an attempt would be made later on in the meeting to make that intention an accomplished fact.

MR. G. STUDLEY seconded the proposition.

MR. H. V. GRUNDY, the retiring President, said that the vote of thanks placed an onerous duty upon him, because he had to acknowledge not merely the kind words which had been said about himself, but also those which applied to the Council and the Hon. Secretary in particular. His session of office had started with a crisis which had persisted during the whole of the season to some extent, and in the latter part of it seemed to be actively developing again. However, he thought they had all done their best to fulfil the duties cast upon them, and on the behalf of the retiring officers he thanked the members most sincerely and warmly for all the support they had received from them during the past session.

Election of Officers

President.—Mr. A. L. Key.

Senior Vice-President.—Mr. W. Holland.

Junior Vice-President.—Mr. J. L. Howard.

Representatives on Technical Committee.—Mr. J. Jackson and Mr. A. Phillips.

Honorary Secretary (pro tem.).—Mr. J. E. Cooke.

Assistant Hon. Secretary.—Mr. F. A. Harper.

Members of Branch Council.—For three years: Mr. J. E. Cooke, Mr. A. Jackson, and Mr. J. A. Reynolds. For one year: Mr. A. Sutcliffe.

Members of the General Council.—Mr. J. E. Cooke, Mr. H. V. Grundy, Mr. R. A. Miles, and Mr. A. Phillips.

Auditors.—Mr. R. R. Hargreaves and Mr. A. Hopwood.

This concluded the proceedings of the annual meeting.

LONDON BRANCH

The annual general meeting of the London Branch of the Institute was held at the Charing Cross Hotel on April 5, with Mr. C. C. Booth, J.P. (Branch-President), in the chair.

Hon. Secretary's Report

MR. G. W. DAGLISH (Branch Hon. Secretary) presented his report on the activities of the Branch for the past year. In the first place, he was very happy to report that, although during the past year international affairs had been somewhat strained, it had not affected the membership of the Branch, which had had another record year. The membership this year was 351, as compared with 312 last year; and he added that the membership had increased by exactly 100 in the last three years. The Branch income had been slightly less than in the previous year, and the expenditure had been slightly greater.

A very interesting variety of lectures had been delivered during the session. The joint meeting with the Sheffield Branch was not a great success as, owing to the distance the members of the Sheffield Branch had had to travel, only about nine of the members of that Branch had been able to attend. But he was sure that all who participated had enjoyed it very much. Last December, the Branch had entertained the Institute of Metals (London Section), and about 110 members of both Institutes had attended that joint meeting. During February of this year a joint meeting was held with the Institute of Welding. That meeting had taken the form of a mock trial, which the members had found to be both instructive and amusing.

It was decided by the Council to hold during the last session a dinner and dance, instead of a dinner as formerly. The Rt. Hon. Lord Meston was the principal guest; and all who had attended would agree that it was a great success.

In January, by the kind permission of Principal Patchin, a meeting of the Branch was held at the Sir John Cass Technical Institute.

The East Anglian Section was going from strength to strength, the membership to date being 57, as against 52 a year ago. He understood from Mr. J. L. Francis, the Secretary of that section, that more than 50 members were present at the section's annual dinner.

In conclusion, Mr. Daglish expressed to the President, the Councillors and all members of the Branch his deep appreciation of their kindly co-operation, which had helped to make his year of office enjoyable.

DR. A. B. EVEREST (Past Branch-President), proposing the adoption of the report, said it was most gratifying, for it showed that membership was still increasing and that records were being broken in all directions. The Branch had had a very successful year—with some reservations. Appreciating by reason of his own experience as Branch Hon. Secretary in the past that that office was no sinecure, Dr. Everest coupled with the resolution for the adoption of the report a hearty vote of thanks to Mr. Daglish for the enormous amount of work he had done on behalf of the Branch.

MR. R. B. TEMPLETON seconded, and endorsed the remarks of Dr. Everest.

The report was adopted, and the vote of thanks to Mr. Daglish was accorded with acclamation. Mr. Daglish briefly responded.

Election of Officers and Council, 1939-40

The following officers were then elected for the ensuing year:—

Branch-President.—Mr. Barrington Hooper, C.B.E.

Senior Vice-President.—Mr. H. W. Lockwood.

Junior Vice-President.—Mr. R. B. Templeton.

Members of Council.—For one year, Mr. P. L. Pincott. For three years, Mr. A. W. G. Bagshawe, Mr. A. J. Murphy and Mr. J. N. Burns.

Delegates to General Council.—Mr. C. H. Kain, Mr. H. W. Lockwood, Mr. B. B. Kent and Mr. C. C. Booth, J.P.

Representatives on Technical Committee.—Mr. C. H. Kain and Mr. A. J. Murphy.

Honorary Auditors.—Mr. Charles Cleaver and Mr. A. R. Bartlett.

Branch Hon. Secretary.—Mr. G. W. Daglish.

The business of the annual general meeting was concluded, and the remainder of the evening was devoted to the presentation and discussion of a Paper on "Bronze Castings of Heavy Sections," by Mr. A. Hopwood.

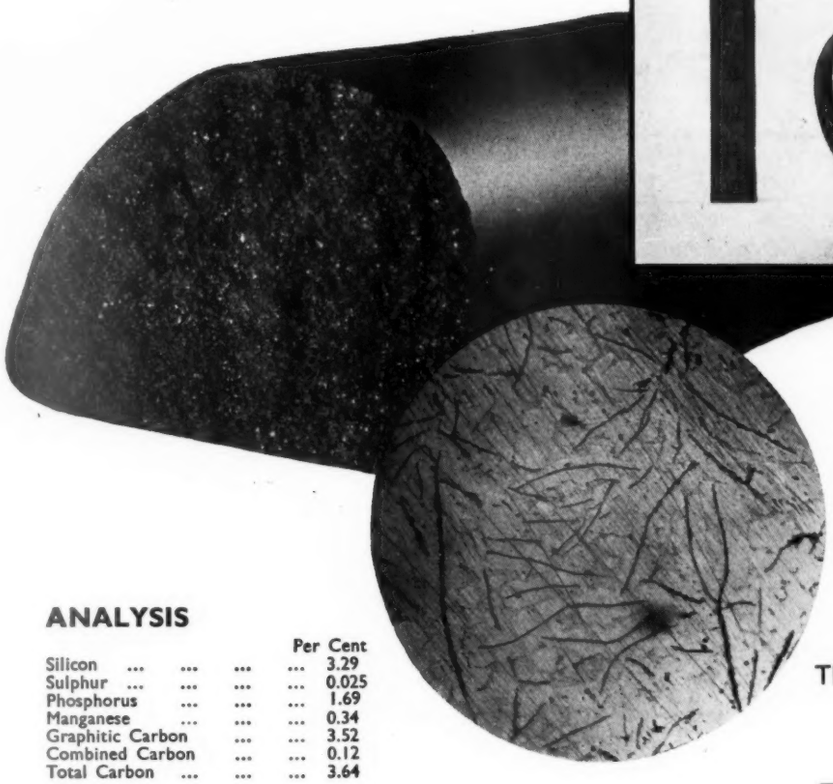
Light Castings need a *Fluid* Iron!

A free-running fluid iron is essential to produce clean, sharply-moulded light castings such as Rainwater pipes, Drain pipes, Builders' Hardware, Baths, Stoves, Gas and Electric Fires, etc. The relatively high phosphorus content of Rixon's (W'bro'.) No. 3 Foundry Iron ensures the necessary fluidity for this class of work.

Rixon's (W'bro'.) Irons are produced in two modern furnaces solely for the open market.

Fluidity Test

The illustration shows a typical spiral cast with a mixture containing Rixon's Iron. The feed to the spiral was only $\frac{3}{8}$-in. diameter.



ANALYSIS

	Per Cent
Silicon	3.29
Sulphur	0.025
Phosphorus	1.69
Manganese	0.34
Graphitic Carbon	3.52
Combined Carbon	0.12
Total Carbon	3.64

THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM

The largest producers of Pig Iron (for Sale) in Great Britain

RIXON'S (W'BRO') No. 3 Foundry Iron

The Week's News in Brief

Trade Talk

THE CARGO FLEET IRON COMPANY, LIMITED, Middlesbrough, are to put another furnace into operation which has been out of commission for relining.

BROOKES (OLDBURY), LIMITED, engineers and ironfounders, of Oldbury, Birmingham, are making large extensions to their machine, erecting and assembly shops.

TONGE & TAGGART, LIMITED, the Dublin firm of ironfounders, held their first reunion in the Dolphin Hotel, Dublin, when Mr. D. Bell, manager of the foundry, welcomed the directors, staff and guests.

THE DUKE OF GLOUCESTER, accompanied by Lord Weir and other directors of the firm, paid a visit to the engineering works of G. & J. Weir, Limited, at Cathcart, Glasgow, last Saturday. His Royal Highness toured the various departments, and saw work in progress on Admiralty contracts.

THE TURKISH AUTHORITIES have placed contracts for 58 locomotives in Britain. The value of the order is around £1,000,000. Twenty-four locomotives will be built by the Vulcan Foundry, Limited, 24 by Beyer Peacock & Company, Limited, and 10 by Robert Stephenson & Hawthorns, Limited.

HEAD, WRIGHTSON & COMPANY, LIMITED, of Stockton and Thornaby, engineers and foundrymen, have completed negotiations for the acquisition of a site near Seaton Carew on the north bank of the Tees for the establishment of a factory for the production of automobile and aircraft components. Work on the erection and equipment of the factory is to be started at once.

THE UNITED KINGDOM GAS CORPORATION has placed with the Stanton Ironworks Company, Limited, of Nottingham, a £90,000 order for 52 miles of high-pressure gas mains. The pipes will form the main underground artery of the first stage in the West Yorkshire gas grid. The order comprises more than 20,000 large-diameter pipes weighing up to 16 cwt. each and individually tested to withstand an air pressure of 60 lbs. per sq. in.

SURPRISE HAS been caused in Eire by the suspension of work by Allied Ironfounders (Ireland), Limited, at their factory at Waterford. At the last annual meeting of shareholders a deficit of over £12,000 was recorded, and a special committee was appointed to look after the interest of the shareholders. It is understood that this committee has now made arrangements to meet the directors with a view to solving the present problem, and it is hoped that the parent body will be able to arrive at a satisfactory solution of the existing difficulties. The factory gave employment to 150 hands.

SOME 30 ORDERS for mercantile tonnage have been placed with Scottish shipbuilders in the past two weeks. The latest contracts for cargo tonnage come from the Hain Steamship Company, Limited, London, orders for three 9,000-ton motorships having been placed on the Clyde by these owners. One ship will be built by each of the following firms:—Barclay, Curle & Company, Limited, Whiteinch; Alex. Stephen & Sons, Limited, Linthouse; and Lithgows, Limited, Port Glasgow. Propelling machinery for all three vessels will consist of Doxford opposed-piston oil engines, which will be built by Barclay, Curle & Company, Limited.

ACCORDING to a report published in the German newspapers from Belgrade, the British heavy industries have offered to supply 250 locomotives to the Jugoslav State railways at a unit price of between 1.6 and 1.7 million dinar. The offer is said to be accompanied by the proposed grant of a credit over a period of 12 years, with interest at the rate of 5 to 6 per cent., delivery to be completed in two years. The current Jugoslav Budget proposals contemplate the exemption from import duties and all Customs charges, of railway rolling stock, locomotives and electrical plant for the service of the State railways, including signalling and other track equipment.

THE GENERAL SECRETARY of the Ironfounding Workers' Association (Mr. H. Murdoch) has just issued the annual report at Falkirk. The financial position, it is stated, has suffered because of so much unemployment and short time amongst the members. The Association's funds show a decrease of £4,408 15s. 3d. since December, 1937, and they now stand at £35,341 12s. During the last half of 1938, the Executive had varied and complex questions to deal with, and it was necessary under the circumstances to ask a section of the members to suffer a wage reduction to try to safeguard the rainwater and soil sections of the trade from being further encroached upon by a new method of producing these goods. The membership has just passed the 12,000 mark, an increase for the year of 121. The Executive, concludes Mr. Murdoch, look forward with some confidence that 1939 will bring a much needed return to something like normal conditions in the light castings industry. Mr. Harry Sinclair (Warrington), the English organiser, in his section of the report, states that the number of members either wholly unemployed or on three or four days a week in December last was 2,758—practically one-third of the active membership. Among the causes for this were the uncertainty of affairs at home and abroad and the rearmament programme; the productivity of modern machines, from the hand to the hydraulic and electric machines, with the continuous-casting process; and the introduction of other materials in the manufacture of goods which had always been considered the monopoly of cast iron.

Personal

MR. V. C. FAULKNER has changed his address to 21, Crescent Court, Surbiton, Surrey.

MR. OAKLEY A. BUSH, who for several years was the special representative in Europe for Norton Company, Worcester, Mass., U.S.A., has joined Norton Grinding Wheel Company, Limited, Welwyn Garden City, as assistant to the general manager.

MR. A. M'CULLOCH, one of the oldest employees of the National Steel Foundry (1914), Limited, Leven, who was foreman of the dressing shop for 27 years, has received presentations from the staff and employees on the occasion of his leaving to enter the brewery trade.

SIR ROBERT HADFIELD was for the second year in succession unable to attend the annual meeting of Hadfields, Limited, which took place on March 30. Although he is in better health than he was a few months ago, Sir Robert was prevented by medical advice from attending the meeting. Sir Robert is to receive the honorary Freedom of the City of Sheffield.

Wills

YOUNG, G. R., of Darlington, late managing director of the Darlington Railway Plant & Foundry Company, Limited £25,719

KIRKPATRICK, SAMUEL, director and secretary of Harrison & Company (Lincoln), Limited, malleable-iron and steel founders £2,150

CHESSHIRE, COL. JOHN I., chairman and managing director of Izons & Company, Limited, ironfounders and hollow-ware manufacturers, of West Bromwich £64,994

Obituary

THE DEATH has occurred of Mr. John Clark, who had been manager of James Ferguson & Son, Tay Street Foundry, Tayport, for 17 years. He was 68 years of age.

MR. E. W. FRASER-SMITH, secretary and treasurer of the North-East Coast Institution of Engineers and Shipbuilders, died recently. He had been secretary and treasurer of the Institution since the latter part of 1911.

MR. JAMES BUTLER, for many years a director of Harrison & Company (Lincoln), Limited, iron founders, has died, aged 78. He joined the firm as a workman 53 years ago, became works manager, and resigned his directorship at the beginning of this year.

THE DEATH occurred last Thursday of Mr. Thomas Wood, chairman and managing director of John Wood & Sons, Limited, Barley Brook Foundry and Engineering Works, Wigan. Mr. Wood, who was 69 years of age, had been associated with the firm all his business career.

Company Reports

Quirk, Barton & Company, Limited.—Final dividend of 6 per cent., making 8½ per cent.

Stewarts and Lloyds, Limited.—Dividend for 1938 on the deferred stock and the liaison deferred shares of 12½ per cent.

Ideal Boilers & Radiators, Limited.—Net profit for 1938, after depreciation, tax and N.D.C., £190,644; brought in, £414,517; dividend (free of tax) on the 700,000 £1 ordinary shares, £157,500; carried forward, £397,661.

Anglo-Greek Magnesite Company, Limited.—Profit for 1938, £17,500; brought in, £6,339; 3 per cent. interim dividend on ordinary shares, £3,750; dividend on 8 per cent. cumulative preference shares, £4,000; final dividend of 5 per cent. on the ordinary shares, £6,250; to taxation reserve, £2,250; carried forward, £7,590.

Gibbons (Dudley), Limited.—Net profit for 1938, after providing for income tax, N.D.C., and depreciation, £26,481; brought in, £12,100; 7 per cent. preference dividend, free of tax, £2,100; dividend of 10 per cent. on the ordinary shares, £9,697; bonus of 2½ per cent., £2,424; part of cost of modernising works written off, £4,000; to dividend equalisation fund, £2,500; to reserve, £5,000; carried forward, £12,160.

Colvilles, Limited.—Trading profit for 1938, £919,596; dividends from subsidiary companies, £129,005; total profit, £1,048,601; brought in, £288,251; depreciation and obsolescence, £300,000; income-tax and N.D.C., £285,000; to reserve, £150,000; dividend on the 5½ per cent. cumulative preference stock, £80,437; final dividend on the ordinary stock of 5 per cent., making 8 per cent. Meeting, April 27.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Barking Foundry & Engineering Company, Limited, River Road, Barking, Essex.—Capital, £1,000. Directors: Lt.-Col. Viscount Bridgeman, P. Winn, E. Winn and T. M. Grigson.

Langley Alloys, Limited.—Capital, £60,000. Subscriber: N. S. Oakley, Llangefni, Canadian Avenue, Catford, London, S.E.6.

Metallurgical Holding Company, Limited.—Capital, £50,000. Subscriber: N. Tietjen, 182, Woodman Street, North Woolwich, E.16.

Contracts Open

Alnwick, April 22.—Provision and laying of 1,350 yds. of 3-in. spun-iron and 1,230 yds. of 4-in. spun-iron mains, complete with valves, hydrants, etc., for the Rural District Council. Mr. O. M. Farrell, surveyor, Old Court Buildings, 34, Green Batt, Alnwick. (Fee £2 2s., returnable.)

Bangor, April 24.—Providing and laying about 2,430 yds. of 8-in. cast-iron water main, for the Town Council. Mr. R. M. Moore, town clerk, Town Hall, Bangor, County Down. (Fee £5 returnable.)

Forthcoming Events

APRIL 21.

Junior Institution of Engineers (Sheffield Section):—"The Electric Furnace—Its Application to Steelworks' Practice," Paper by H. A. Wainwright, at Metallurgical Club Rooms, 198, West Street, Sheffield, at 7.30 p.m.

Institute of British Foundrymen

APRIL 21.

Birmingham, Coventry and West Midlands Branch:—Annual general meeting, at James Watt Memorial Institute, Birmingham, at 7.30 p.m.

Middlesbrough Branch:—Visit to laboratories of Head, Wrightson & Company, Limited, Thornaby-on-Tees.

APRIL 29.

West Riding of Yorkshire Branch:—Annual general meeting; "Fuel for the Foundry," Paper by A. E. Wilson, at Technical College, Bradford, at 6.30 p.m.

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. . . gives *longer · life* in Rotary furnaces

Here is proof of the remarkable durability of Rotaline . . . this photograph, reproduced by the courtesy of L.M.S. Rly. Co., shows a Sesci furnace at their Crewe Works being tapped. This furnace, which is used for melting steel, is lined with Rotaline, and at the time the photograph was taken the furnace had completed 140 heats. The lining is still in good condition. Rotaline presents a strong, durable lining resistant to hard usage, while its low volume change obviates cracking and flaking of the lining.

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Raw Material Markets

The demand for iron and steel continues to expand, and activity at the producing works is brisk, largely as a result of Government orders. Low-phosphorus iron and hematite are moving away in substantial tonnages, but high-phosphorus iron, while in better request, is still a quiet section.

Pig-Iron

MIDDLESBROUGH.—The current output of Cleveland foundry iron is still more than sufficient to meet consumers' restricted demands, but the call for contract deliveries is steadily increasing, and makers are looking forward to the time when they will be able to expand their productions. A satisfactory feature of the market has been the better outlook for works engaged in meeting shipbuilding requirements. For delivery to consumers in the Middlesbrough and Falkirk areas, No. 3 Cleveland G.M.B. foundry iron is quoted at 99s., with No. 1 foundry at 102s. and No. 4 foundry and No. 4 forge at 98s., all less 5s. per ton rebate. These quotations are expected to operate up to the end of the first half of the year.

Quite a number of hematite consumers have covered their needs up to the end of June, and the market is undoubtedly firmer than it was at the beginning of the year. The current rate of output is ample, but stocks are steadily being cleared. East Coast hematite mixed numbers are quoted at 120s. on the North-East Coast, 125s. 6d. in Sheffield, and 131s. in the Midlands, all less 5s. rebate.

LANCASHIRE.—Although some consumers in this area are still badly placed for work, there has recently been an improvement, following the receipt of numerous Government orders. Textile-machinery makers and light-castings makers are mostly quiet, but the demand for iron from the machine-tool and other speciality engineers is on a good scale. Generally speaking, business is restricted to near-date deliveries. For delivery to users in the Lancashire price zone, offers of Derbyshire and Staffordshire No. 3 foundry iron are on the basis of 104s., with Northamptonshire No. 3 at 102s. 6d. Derbyshire forge iron is quoted at 101s. or 103s. per ton, according to the class of consumer. Contract deliveries of hematite are being called for more frequently, but new business is still on the quiet side.

MIDLANDS.—Business in high-phosphorus iron continues to be rather dull. There has been little improvement in the condition of the light-castings foundries, most of which are still on short time. Orders have been slightly more plentiful of late, however, and some consumers have booked supplies over the next few months. For delivery to Birmingham and Black Country stations, Derbyshire No. 3 foundry iron is quoted at 101s., with Northants at 98s. 6d., both less 5s. rebate. With the heavy engineers very busy, large tonnages of low-phosphorus iron and hematite are being taken up, and business in these sections is active. Some producers of the former are already fully sold over a few months ahead. The price of low-phosphorus iron ranges from £5 5s. to £6 per ton, according to quality and quantity.

SCOTLAND.—Government orders and a substantial increase in the number of shipbuilding contracts recently placed have helped to improve the outlook in this area. Unfortunately, there is still little change among the light-castings foundries, which are quiet. The official quotations are still 108s. for No. 1 foundry iron and 105s. 6d. for No. 3, f.o.t. furnaces. Steel-making irons are being taken up in heavier tonnages as a result of the increased production at the local works. Prices are:—Hematite mixed numbers, 120s. 6d.; basic, 92s. 6d., both less 5s. rebate, delivered works.

Coke

Foundry coke continues to move away satisfactorily. Export orders are rather heavier than of late and the market is firm. For delivery to Birmingham and district, the minimum quotation for Durham and Welsh coke is 50s. 6d. per ton, and makers have made it clear that there will be no change at any rate before the end of June.

Steel

Following the announcement of the Government's plans for the assistance of the shipbuilding industry, there has been a number of important orders placed with the various shipyards of the country. As a result, the demand for steel suitable for this trade has shown a marked expansion. Other sections of the steel trade are busy on armament work and are likely to continue so for a good time to come. The sheet trade is actively employed in dealing with the requirements of air-raid shelters.

Scrap

It is reported that the British Iron and Steel Federation have purchased, on behalf of the British steel industry, 50,000 tons of steel scrap from the United States. Although this imported material will relieve to some extent the shortage in this country, much more is urgently required to meet consumers' requirements. At present, the demand considerably outstrips the available supplies in all areas.

Metals

An easy tone has ruled in the non-ferrous metal markets during the past few days. Although President Roosevelt's appeal appears to have been met in Germany and Italy with an outburst of vituperative rage, the confidence inspired by the American President's gesture in the rest of Europe cannot be doubted. A conference of nations on the lines suggested by Mr. Roosevelt would go a long way towards removing the political and economic differences which are now compelling them to live in a state of war preparedness. Until these difficulties have been minimised unsettled conditions must inevitably continue to depress the commercial world.

Copper.—There has been little new business done during the past week or two. The outlook naturally depends on the international situation to a large extent; the acceleration of the rearmament programme should ensure that consumption is maintained for a considerable time to come, but orders for civil work are unlikely to be very substantial until more settled conditions prevail. In the United States, producers have further reduced their quotation, which now stands at 10.50 cents per lb. Even so, it is not expected that buyers will be induced to enter into new business on a large scale. The American Copper Institute announces that world stocks of refined copper increased by 13,277 short tons during March to 506,391 tons. The apparent world consumption totalled 158,000 tons, while the world output by mines and smelters amounted to 164,000 tons. The world production of refined metal totalled 171,000 tons.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £42 1s. 3d. to £42 3s. 9d.; Friday, £41 17s. 6d. to £41 18s. 9d.; Monday, £41 13s. 9d. to £41 16s. 3d.; Tuesday, £41 12s. 6d. to £41 13s. 9d.; Wednesday, £41 15s. to £41 16s. 3d.

Three Months.—Thursday, £42 8s. 9d. to £42 10s.; Friday, £42 5s. to £42 6s. 3d.; Monday, £42 to £42 2s. 6d.; Tuesday, £42 to £42 1s. 3d.; Wednesday, £42 1s. 3d. to £42 2s. 6d.

Tin.—Large purchases of tin for early delivery resulted in the spot quotation reaching the highest level since October, 1937, on Tuesday. The weekly report issued by Rudolf Wolff & Company states that offerings of near tin have been relatively scarce and, at the same time, the forward position has been subjected to a fair amount of selling; in consequence, the double effect has been a further expansion of the backwardation. Business with consumers has been quiet both in this country and on the Continent, but in America rather more activity has from time to time been reported. In London the market is still very largely dominated by outside influences, and sentiment, affected by the unsettled political situation, exerts a very restricting influence on business.

Official quotations were as follow :—

Cash.—Thursday, £215 5s. to £215 10s.; Friday, £216 5s. to £216 10s.; Monday, £216 15s. to £217; Tuesday, £218 5s. to £218 7s. 6d.; Wednesday, £218 10s. to £218 15s.

Three Months.—Thursday, £213 to £213 5s.; Friday, £214 to £214 2s. 6d.; Monday, £214 10s. to £214 12s. 6d.; Tuesday, £215 15s. to £216; Wednesday, £216 10s. to £216 15s.

Spelter.—Quiet conditions have ruled in this market, and consumers are showing little interest in new contracts. Firms engaged on Government orders are busy, but most other concerns are still unsatisfactorily placed for work.

Daily market prices :—

Ordinary.—Thursday, £13 6s. 3d.; Friday, £13 7s. 6d.; Monday, £13 6s. 3d.; Tuesday, £13 6s. 3d.; Wednesday, £13 7s. 6d.

Lead.—Business both at home and on the Continent has been comparatively brisk of late, but the United States market remains easy, and the quotation has been lowered to 4.75 cents per lb., New York.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 1s. 3d.; Friday, £14 2s. 6d.; Monday, £14 7s. 6d.; Tuesday, £14 2s. 6d.; Wednesday, £14 7s. 6d.

Scrap.—There has been a moderate amount of activity in this section, but the tone of the market has been rather less firm since the holidays.

Approximate selling prices for old metal :—New aluminium cuttings, £70; rolled, £57; cast, £32; foil, £80. Copper, £39 to £43; braziery, £35 to £36. Brass (clean), £19 to £24. Zinc, £10. Lead, £13 10s. Gunmetal, £38.

Company Meetings

Vulcan Foundry, Limited

Figures for the past year indicated that the works had been more fully employed, and that they were slowly recovering from a period when they had to draw on their reserves, said Mr. Walter Woodbine Parish, when presiding at the annual meeting of the Vulcan Foundry, Limited. He added that the board regarded it as essential, however, under present conditions, that the company should rebuild its reserves. They were again employed on work for the Buenos Ayres Great Southern Railway, had built and delivered 20 locomotives to their order, and had also completed orders for railways in India and to the order of the Crown Agents for the Colonies for the Gold Coast Railway, but they had had no order from railways in the home country. He still maintained that both the railways of Great Britain and the locomotive builders in this country would benefit to no small extent were it to be found possible for them to place part of their annual requirements with the old-established locomotive building firms. The railways were asking for a "square deal," and he hoped they would get it. At the same time he hoped they would appreciate the desirability of themselves giving a "square deal" to the locomotive builders.

Worthington-Simpson, Limited

The annual meeting of Worthington-Simpson, Limited, was held in London last week. Mr. S. R. Beale (chairman), who presided, said that last year he told shareholders that the company's order-book was in a satisfactory condition, and he could say the same to-day. Again, there had been delay, over which they had no control, in the completion of certain large contracts which should tend to increase this year's sales compared with those of last year. It seemed probable that the volume of business to be completed this year would be increased by the demands that had been, and would be, put upon them in connection with rearmament and A.R.P. requirements.

A. Reyrolle & Company, Limited

Sir A. N. L. Wood, Bt., presiding at the annual meeting of A. Reyrolle & Company, Limited, said that they attained in 1938 the greatest output of any year in their history. Orders for their standard productions were lower than in the previous year, which was an exceptional one, but a satisfactory level of demand was maintained, and since the end of the year it had tended to increase. They also received a satisfactory amount of work in the export market, in spite of more competition. In addition to their normal range of productions they had undertaken certain important contracts for the Government. They looked forward to another year of great activity.